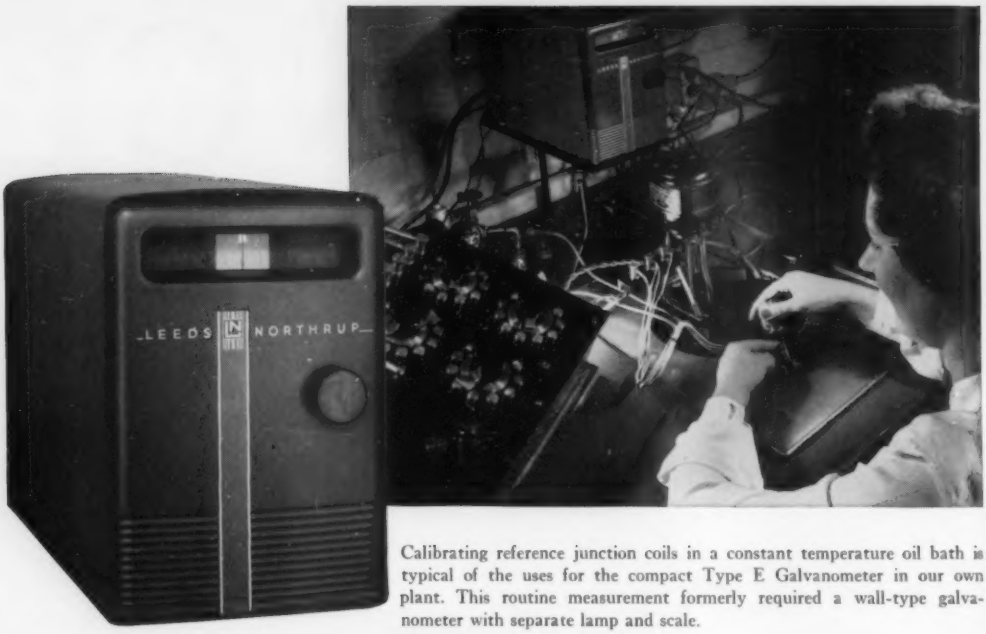
SCIENCE

MARCH 21, 1952

VOLUME 115 NUMBER 2986

Contents

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



Calibrating reference junction coils in a constant temperature oil bath is typical of the uses for the compact Type E Galvanometer in our own plant. This routine measurement formerly required a wall-type galvanometer with separate lamp and scale.

"E" Galvanometer Saves Space and Time In Our Own Laboratory

THIS L&N Type E Galvanometer is the "just right" answer—in sensitivity and speed—for handling a variety of null measurements. Simply place the instrument wherever convenient, plug into a standard outlet, and it's ready for accurate, dependable use.

Compact and self-contained, Type E has the following features:

1. It is easily placed at *any* eye level;
2. Spots show brightly on recessed scale. No scale-shade is required . . . even in a well-lighted room;
3. Zero is adjusted simply by turning the knob near the scale;
4. Unique two-spot design virtually eliminates "spot-chasing". The larger primary spot moves with full sensitivity. The smaller—but brighter—spot, "geared down" to a fraction of this sensitivity, moves so slowly that the user can see direction of unbalance; hence restores balance without hunting.

Type E sensitivity per mm. can be 0.5 microvolt (total circuit resistance 67 ohms); 0.005 or 0.0005 microampere—with periods of 3.0, 2.5, and 3.0 seconds respectively. The moving systems necessary to change sensitivity are interchangeable. Thus, a *single* Type E, with two additional systems, gives the same variety of characteristics as *three* complete galvanometers.

Catalog ED Sec. 1 sent on request. Write Leeds & Northrup Company, 4926 Stenton Ave., Philadelphia 44, Penna.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

Jrl Ad ED22(6)

Source Books in Science

As long ago as 1924 I conceived a plan for the preparation and publication of source books in the history of science. The aim was to present the most significant passages from the works of outstanding men in mathematics and the physical sciences from about 1400 to 1900. Later it seemed advisable to add a volume dealing with the scientific contributions of the ancient Greeks and another for medieval science. A volume containing important selections from the same fields of science from 1900 to 1950 is now under way.

The books of this series were not intended to be textbooks, although several have been used in that way. The primary goal was to make the most important scientific material readily available for courses in the history of science. With such works at hand, any teacher could give practically as good a course as those offered at large universities where original source material is preserved. Furthermore, since the material was to be selected by experts in their respective fields, a decided advantage would attach to the "Source Books."

With the original idea in mind, I began search for an advisory board which, ultimately, was composed of seven eminent scientists and an equal number of prominent philosophers, including:

Joseph S. Ames, *The Johns Hopkins University*
Frederick Barry, *Columbia University*
Harold C. Brown, *Stanford University*
R. T. Chamberlin, *University of Chicago*
Morris R. Cohen, *College of the City of New York*
Edwin G. Conklin, *Princeton University*
Arthur O. Lovejoy, *The Johns Hopkins University*
George H. Mead, *University of Chicago*
William P. Montague, *Columbia University*
Harlow Shapley, *Harvard University*
Wilmon H. Sheldon, *Yale University*
David Eugene Smith, *Columbia University*
Edward G. Spaulding, *Princeton University*
Alfred M. Tozzer, *Harvard University*

The suggestions given by these men collectively and individually have been invaluable. The helpful advice of the late J. McKeen Cattell and William S. Learned, of the Carnegie Foundation for the Advancement of Teaching, cannot be overestimated. The endorsements, too, of several learned societies added considerably to the momentum of the undertaking in its early stages.

The Carnegie Corporation of New York granted $10,000 as a revolving fund to help finance the project, and the McGraw-Hill Book Company undertook the publication and distribution of the entire series. The fact that approximately 18,000 copies of the several works have been sold indicates that the series is serving a useful purpose.

The first volume, *A Source Book in Astronomy,* edited by Shapley and Howarth, came from the press early in 1929 and was followed by *A Source Book in Mathematics,* edited by David Eugene Smith. *A Source Book in Physics,* by W. F. Magie, appeared in 1935, and *A Source Book in Geology,* by Mather and Mason, followed in 1939. World War II interrupted publication, but in 1948 *A Source Book in Greek Science,* by Cohen and Drabkin, was placed on the market. *A Source Book in Animal Biology,* edited by Thomas S. Hall, appeared in 1951, and *A Source Book in Chemistry,* by Henry M. Leicester, is in press. *A Source Book in Botany* is in preparation, and, as already indicated, *A Source Book in Medieval Science,* by McKeon and Clagett, is partly in manuscript form. The *Source Book in Twentieth Century Science* (*1900–1950*) is in the hands of Harlow Shapley, Kirtley F. Mather, Garrett Birkhoff, Henry Margenau, Thomas S. Hall, and Henry M. Leicester.

These volumes, now on the market, range from about 500 to 700 pages each. Initially they sold for about $5.00 but, thanks to unfortunate economic conditions, the prices of the more recent ones have risen. It is hoped that the project, which is now nearing completion, has added something of permanent value to the literature of science.

Gregory D. Walcott

Department of Philosophy
Long Island University

SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at the Business Press, 10 McGovern Ave., Lancaster, Pa. Entered as second-class matter at the Post Office at Lancaster, Pa., January 13, 1948, under the Act of March 3, 1879. Acceptance for mailing at the special rate postage provided for in the Act of February 28, 1925, embodied in Paragraph (d-2) Section 34.40 P. L. & R. of 1948.

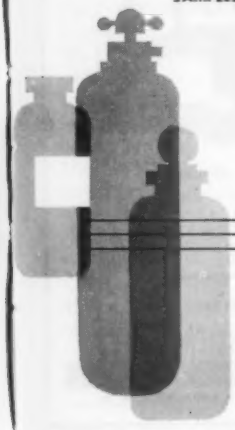
All correspondence should be sent to SCIENCE, 1515 Massachusetts Ave., N.W., Washington 5, D. C. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. Four weeks' notice is required for change of address, and an address stencil label from a recent issue must be furnished. Claims for a missing number will be allowed only if received within 60 days from date of issue.

Annual subscriptions, $7.50; single copies, $.25; foreign postage, outside the Pan-American Union, $1.00; Canadian postage, $.50. Special rates to members of the AAAS.

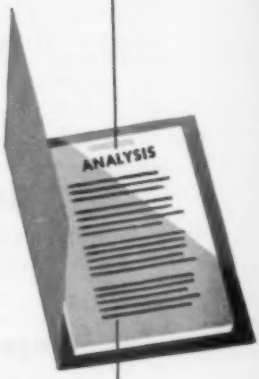
The AAAS also publishes THE SCIENTIFIC MONTHLY. Subscription and advertising rates on request.

ANALYTICAL MASS SPECTROMETER

GAS OR LIGHT LIQUID SAMPLES



ISOTOPE - RATIO MASS SPECTROMETER



ELECTRICAL COMPUTER

this analytical laboratory is here to serve you

Since 1949 Consolidated has operated this precision analytical service—utilizing mass spectrometry under the supervision of Consolidated's experienced staff. It serves research organizations and industry having analytical problems, but where the number of samples does not justify the purchase of an instrument.
Sample requirements are very small. Recommended containers are 100 cc for gas and 5 cc for liquid. Where isotope ratios are required, samples must be in the vapor phase. Cost of the service is low.
For further information, request Bulletin CEC-1813.

consolidated engineering corporation

analytical service

300 No. Sierra Madre Villa
Pasadena 8, California

CEC *Analytical Instruments for Science and Industry*

What GENERAL ELECTRIC People Are Saying

E. D. TROUT

X-Ray Department

COBALT-60 IRRADIATOR FOR TELETHERAPY: Late in 1949 the Medical Division of the Oak Ridge Institute of Nuclear Studies and the M. D. Anderson Hospital for Cancer Research entered into a joint program for the design, construction and experimental testing of a large Cobalt-60 teletherapy unit. A portion of the cost of the project was supplied by the Damon Runyan Fund as a grant to the hospital. In 1951 these institutions entered into a contract with the X-Ray Department of the General Electric Company calling for the construction of such a unit.

The unit was constructed to the basic design of L. G. Grimmett, Ph.D., head of the Department of Physics, M. D. Anderson Hospital.

The Cobalt-60 irradiator has been installed in a room constructed for it at the Oak Ridge Institute of Nuclear Studies, and has been loaded with a 200 curie source loaned by Dr. Max Cutler of the Chicago Tumor Institute. A preliminary report on the irradiator was presented before the Radiological Society of North America at its recent annual meeting. Further studies of the shielding about the source, beam characteristics, and depth dose are under way, as are biological studies. When these are completed the irradiator will be reloaded with a 1000 curie (effective) source from the Chalk River pile. The equipment will then be transferred to the M. D. Anderson Hospital for Cancer Research at Houston, Texas, for use in the treatment of cancer.

The 1000 curie source should deliver approximately 90 roentgens per minute at the end of the 50 cm. treatment cones. An x-ray generator operating at 1 mv. and 3 ma. produces 150 roentgens per minute, and a 2 mv. x-ray unit operating at 1.5 ma. delivers 600 roentgens at this distance. The Cobalt-60 beam, being nearly monochromatic at 1.2 mev, should be more nearly comparable to the 2 mv. x-ray unit in the matter of depth dose.

The future of Cobalt-60 teletherapy will generally be determined by the availability and cost of the source.

AIEE
New York City
January 7–8, 1952

A. D. MARSHALL

Corporate Services Division

SOCIAL SECURITY—A PROBLEM FOR AMERICAN BUSINESS: A recent report by the Chamber of Commerce of the United States estimates that 300 welfare plans take a third of all government tax dollars—$22,800,000,000 during the fiscal year of 1949–50—or $575 for every taxpaying family.

Over the years the leaders of our business enterprises have solved many problems through their own individual initiative. They have made more products available at less cost to the American worker than any nation in the history of the world. But we are now confronted with the fundamental problem of whether American business can face and solve, through the initiative of its managers and businessmen, the problems involved in social security or whether these are to be taken over by bureaucratic government control and resolved in a way which will lead us directly from social security into socialism. There appears to be little doubt that when a government takes over the savings of all the people for the emergencies of life—unemployment, sickness, death of the breadwinner, old age, and the many other things which the social planners include in the so-called social security program—and directs to whom and under what circumstances that money shall be paid, the government which does that must soon take the responsibility of directing the lives and actions of all of us.

Just as the progress made by the American free enterprise system has been based on the individual efforts of thousands of businesses throughout our country, so in this social field American business can and should plan individualized programs as a firm foundation under our free competitive system.

Annual Meeting,
Framingham Chamber of Commerce
January 15, 1952

Carboxylation Reactions and Photosynthesis[1]

Severo Ochoa and Wolf Vishniac[2]

Department of Pharmacology, New York University College of Medicine, New York

THE UTILIZATION OF ATMOSPHERIC CARBON DIOXIDE in the synthesis of organic compounds has until recently been thought to be the prerogative of photosynthetic and chemosynthetic organisms. The general occurrence of carbon dioxide fixation in heterotrophic cells was recognized only when isotopes of carbon became available (*1*). The intensive study of heterotrophic carbon dioxide fixation that ensued made it possibe to approach the problem of photosynthesis in the light of what had been learned about carbon dioxide fixation reactions in general. This paper deals with enzyme systems which, on suitable coupling with preparations of chloroplasts from green leaves, are capable of mediating a light-dependent fixation of carbon dioxide. The study of these systems may throw considerable light on the basic mechanisms of photosynthesis.

In 1935 Wood and Werkman demonstrated that typical heterotrophic bacteria—i.e., organisms which, like animal cells, depend on a supply of ready-made organic compounds for growth and activity—were able to assimilate carbon dioxide (*1*). The fixed carbon was present in the carboxyl groups of organic acids, such as malic, fumaric, and succinic (*2*). Evans and his collaborators discovered that CO_2 fixation in dicarboxylic acids such as malic and fumaric occurred in cell-free extracts of pigeon liver (*3, 4*). The occurrence of CO_2 fixation in a cell-free system made possible a detailed enzymatic study of these reactions. It was found in this laboratory that carbon dioxide entered the carboxyl groups of the above acids by reacting with pyruvic acid and $TPNH_2$ to form L-malic acid and TPN (Reaction 1).[3] This reversible carboxylation is

$$(1)\quad CO_2 + \text{pyruvate} + TPNH_2 \underset{}{\overset{(Mn^{++})}{\rightleftharpoons}} \text{L-malate} + TPN,$$

catalyzed by an enzyme, first found in pigeon liver, which specifically requires TPN and manganous ions for activity (*5*). Further study showed that this enzyme, referred to as "malic" enzyme, is widely distributed in animal and plant tissues. Experiments with highly purified "malic" enzyme from pigeon liver established the reversibility of Reaction 1. Its course can be followed in a spectrophotometer by measuring the optical density of the reaction mixture at 340 mμ. On addition of "malic" enzyme to a solution containing L-malate, TPN, and manganous ions, the optical density of the solution increases as TPN is reduced (Fig. 1, Curve 1). Conversely, the optical density decreases when "malic" enzyme is added to a solution of $TPNH_2$, carbon dioxide, pyruvate, and manganous ions (Curve 3). Curve 2 illustrates a similar experiment, except that carbon dioxide was omitted initially and added at the point indicated by Arrow *a*. The initial small decrease in optical density was caused by a contaminating enzyme.

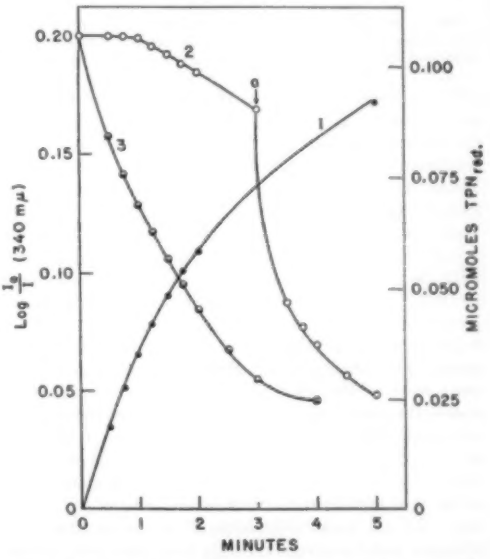


FIG. 1. Spectrophotometric measurement of the reversible reaction L-malate + TPN $\rightleftharpoons$ pyruvate + CO_2 + $TPNH_2$ catalyzed by the "malic" enzyme (*5*).

At low partial pressure of CO_2 the equilibrium position of Reaction 1 favors almost complete decarboxylation. This reaction thus permits the quantitative determination of small amounts of malic acid by spectrophotometric measurement of the reduction of TPN (*5*). However, it is possible to bring about the synthesis of L-malic acid from pyruvic acid and

[1] Based on a lecture delivered by one of us (Ochoa) at the Marine Biological Laboratory, Woods Hole, Mass., July 6, 1951, and on a paper read at the 26th annual meeting of the American Society of Plant Physiologists, Minneapolis, Minn., September 11, 1951.

[2] Fellow of the National Institutes of Health, U. S. Public Health Service.

[3] The following abbreviations are used: DPN and $DPNH_2$, oxidized and reduced diphosphopyridine nucleotide; TPN and $TPNH_2$, oxidized and reduced triphosphopyridine nucleotide; ATP, adenosine triphosphate; ADP, adenosine diphosphate.

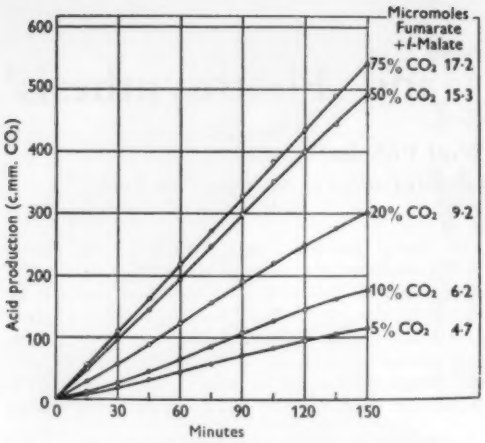


FIG. 2. Biosynthesis of malate and fumarate by CO_2 fixation through the reaction between glucose-6-phosphate, pyruvate, and CO_2 (*6*).

CO_2 by coupling with a reaction that provides a steady supply of $TPNH_2$. The enzymatic oxidation of glucose-6-phosphate is TPN-linked (Reaction 2) and has been coupled to the "malic" enzyme system (*6*). When glucosephosphate dehydrogenase and "malic" enzyme are added to a solution containing glucose-6-phosphate, pyruvate, carbon dioxide, TPN, and manganous ions, glucose-6-phosphate is oxidized and TPN is reduced (Reaction 2). $TPNH_2$ reacts with pyruvate and CO_2 to form L-malate and TPN via Reaction 1. TPN can react once more with glucose-6-phosphate, and this cycle is repeated again and again. The oxidation of glucose-6-phosphate maintains most of the TPN in its reduced form and furnishes the hydrogen and the energy required for the reductive carboxylation of pyruvate. The formation of fumarate catalyzed by fumarase (Reaction 3) removes some of the malate formed by Reaction 1 and shifts the equilibrium still further toward CO_2 fixation. The net result (Reaction 4) is the synthesis of L-malate and fumarate from pyruvic and CO_2 at the expense of the oxidation of glucose-6-phosphate.

(2) Glucose-6-phosphate + TPN $\rightarrow$ 6-phosphogluconic acid + $TPNH_2$

(3) L-malic acid $\rightleftharpoons$ fumaric acid + H_2O

(4) Glucose-6-phosphate + pyruvate + CO_2 $\xrightarrow{(TPN,\ Mn^{++})}$ 6-phosphogluconate + L-malate + fumarate + H_2O

When Reaction 4 is allowed to proceed in bicarbonate buffer at pH 7.0 in a Warburg respirometer, an evolution of gas is observed. This is due to the liberation of CO_2 from the bicarbonate by the acid formed when the aldehyde group of glucose phosphate is oxidized to the carboxyl group of phosphogluconic acid. The uptake of CO_2 by pyruvate is balanced by the CO_2 liberated from the bicarbonate by the newly formed carboxyl group of malic and fumaric acid.

Thus, the evolution of CO_2 can conveniently be used to follow the progress of reaction (*6*) and is illustrated in Fig. 2 by an experiment carried out at different partial pressures of CO_2 while maintaining a constant pH of 7.0. Besides measuring the rate of CO_2 evolution as outlined above, the amount of malate + fumarate, formed from the 100 micromoles of pyruvate initially present, was determined at the end of each run by a specific enzymatic method and is shown at the right of Fig. 2 facing the corresponding curves. The method is based on the specific decarboxylation of fumarate and L-malate to lactate and CO_2 by the combined action of fumarase and an enzyme system isolated in this laboratory from *Lactobacillus arabinosus* (*7*). The identity of the L-malic acid formed via Reaction 4 has also been established by isolation (*8*). As expected, the rate of synthesis of malate and fumarate from pyruvate and CO_2 increases with increasing partial pressure of CO_2, but the reaction proceeds at an appreciable rate even with relatively low concentrations of CO_2 in the gas phase. So far we know of no other well-defined enzyme system that is as efficient as the above in bringing about fixation of CO_2. This makes it likely that enzymes of the type of the "malic" enzyme may play an important part in photosynthesis. Vennesland has shown that a TPN-specific "malic" enzyme is widely distributed in the tissues of higher plants (*9*, *10*).

A similar fixation of carbon dioxide can take place in the synthesis of isocitric acid. It was observed in this laboratory (*11*) that isocitric dehydrogenase catalyzes Reaction 5. The course of Reaction 5, like that of Reaction 1, can be followed spectrophotometrically at 340 mμ. Synthesis of D-isocitric acid, like the synthesis of L-malic acid, can be brought about (*11*) by coupling the isocitric dehydrogenase system (Reaction 5) to the oxidation of glucose-6-phosphate (Reaction 2). In the presence of the enzyme aconitase most of the D-isocitrate is converted to citrate (Reaction 6), so that the equilibrium of the over-all reaction is shifted further in favor of carbon dioxide fixation. The net result of Reactions 2, 5, and 6 is the synthesis of citrate from carbon dioxide and α-ketoglutarate at the expense of the oxidation of glucose-6-phosphate (Reaction 7).

(5) CO_2 + α-ketoglutarate + $TPNH_2$ $\xrightleftharpoons{(Mn^{++})}$ D-isocitrate + TPN

(6) D-isocitrate $\rightleftharpoons$ citrate

(7) Glucose-6-phosphate + α-ketoglutarate + CO_2 $\xrightarrow{(TPN,\ Mn^{++})}$ 6-phosphogluconate + citrate

It could now be asked whether carboxylations of the type carried out by the "malic" enzyme and isocitric dehydrogenase participate in photosynthesis. In its over-all results photosynthesis is a reversal of respiration. In respiration, foodstuffs are oxidized to CO_2 and water, with absorption of oxygen and liberation of energy. In photosynthesis the chlorophyll-containing chloroplasts utilize radiant energy to build up organic substance from CO_2 and water, and oxygen is liberated. Essentially, then, CO_2 is reduced by

hydrogens from water. The crucial photosynthetic reaction appears to be the cleavage of water, which makes hydrogen available for biochemical reductions. The energy of the light absorbed by chlorophyll is utilized for the splitting of water. Hill (*12*) was the first to observe that isolated chloroplasts under illumination reduce suitable hydrogen acceptors and evolve oxygen. Quinone, ferricyanide, and dichlorophenolindophenol have been found to function as hydrogen acceptors, and although these compounds have no physiological importance, their use in the study of the Hill reaction has markedly contributed to our knowledge of the fundamental process of photosynthesis. It has been previously suggested (*6, 13*) that the photochemical apparatus of green plants may be capable of reducing pyridine nucleotides (Reaction 8). The reduced pyridine nucleotides in turn may reduce carbon dioxide through reactions such as are mediated by the "malic" enzyme and isocitric dehydrogenase (Reactions 1 and 5). Such a reaction sequence could account for the transfer of hydrogen from water to carbon dioxide (Reaction 9).

$$(8)\quad H_2O + TPN \text{ (or DPN)} \xrightarrow{\text{(light)}} TPNH_2 \text{ (or DPNH}_2\text{)} + \tfrac{1}{2}\,O_2$$

$$(9)\quad H_2O + CO_2 + \text{pyruvate (or } \alpha\text{-ketoglutarate)} \xrightarrow[(\text{light, TPN, } Mn^{++})]{} \text{L-malate (or D-isocitrate)} + \tfrac{1}{2}\,O_2$$

Evidence has been obtained in this laboratory (*14–16*) that illuminated suspensions of green grana from spinach chloroplasts can catalyze the reduction of both TPN and DPN. In this manner the illuminated grana can bring about the reductive carboxylation of pyruvic and α-ketoglutaric acid. Green grana were suspended in a solution containing "malic" enzyme, potassium pyruvate, CO_2, TPN, and manganous ions.

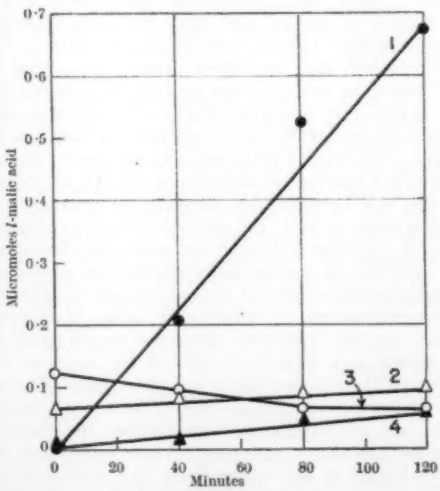


FIG. 3. Photochemical synthesis of malate from pyruvate and CO_2 in the presence of green grana from spinach chloroplasts, pigeon liver "malic" enzyme, and TPN (*15*).

Upon illumination a small amount of L-malic acid was formed, as determined enzymatically (Figure 3, Curve 1). In the dark (Curve 3), or in the absence of either "malic" enzyme (Curve 2) or TPN (Curve 4), no malic acid was found. When the photochemical synthesis of malic acid was carried out in the presence of $C^{14}O_2$, it was found that most of the radioactivity absorbed by the reaction mixture could be recovered by enzymatic degradation from the β-carboxyl of L-malic acid. It has likewise been possible to carry out a photochemical synthesis of citric acid. Green grana were suspended in a solution containing isocitric dehydrogenase, aconitase, potassium α-ketoglutarate, isocitric dehydrogenase, and aconitase. The samples contained $C^{14}O_2$ (4.5×10^6 cpm) and were incubated for 2 hr at 15° C in an atmosphere of 95% nitrogen and 5% CO_2.

TABLE 1

PHOTOCHEMICAL FIXATION OF $C^{14}O_2$ IN MALATE AND CITRATE*

Expt No.	Material analyzed	Radioactivity (cpm)	
		Light	Dark
1	Supernatant fluid	4,790	670
	Chromatographed malate	4,770	530
	CO_2 from β-carboxyl of malate	3,440	360
2	Supernatant fluid	139,000	5000
	Chromatographed citrate and isocitrate	126,000	—

* An aqueous suspension of green grana from spinach chloroplasts (containing 0.6 mg of chlorophyll) was supplemented with small amounts of TPN and $MnCl_2$. In addition, in Expt 1 the mixture was further supplemented with pyruvate and "malic" enzyme from pigeon liver; in Expt 2, with α-ketoglutarate, isocitric dehydrogenase, and aconitase. The samples contained $C^{14}O_2$ (4.5×10^6 cpm) and were incubated for 2 hr at 15° C in an atmosphere of 95% nitrogen and 5% CO_2.

tarate, $C^{14}O_2$, TPN, and manganous ions. Upon illumination, citric and isocitric acid were formed which contained 90 per cent of all the radioactivity absorbed by the reaction mixture. No citric acid was formed in the dark. Typical results illustrating the marked effect of illumination on the fixation of CO_2 by each system are shown in Table 1.

The photochemical carboxylations described above may well exemplify the basic type of reaction through which photosynthetic organisms reduce and assimilate CO_2. In addition, by photochemical reduction of DPN, green grana can bring about a number of other biochemical reductions. The illumination of grana in a solution containing lactic dehydrogenase, potassium pyruvate, and DPN produces lactate through coupling of Reaction 8 with the reaction catalyzed by lactic dehydrogenase (Reaction 10). In the presence of DPN and malic dehydrogenase, which catalyzes Reaction 11, illuminated grana can reduce oxalacetic acid to malic acid. By using glutamic dehydrogenase, which catalyzes Reaction 12, it could be shown that green grana can bring about the reductive amination of α-ketoglutaric acid.

$$(10)\quad DPNH_2 + \text{pyruvic acid} \rightleftharpoons DPN + \text{lactic acid}$$

$$(11)\quad DPNH_2 + \text{oxalacetic acid} \rightleftharpoons DPN + \text{L-malic acid}$$

$$(12)\quad DPNH_2 + \alpha\text{-ketoglutaric acid} + NH_3 \rightleftharpoons DPN + \text{L-glutamic acid}$$

Another type of reduction was carried out with extracts of *Escherichia coli*. Such extracts are known to reduce fumaric to succinic acid with absorption of hydrogen when placed under a hydrogen atmosphere. These same extracts in the absence of hydrogen but in the presence of green grana can reduce fumaric to succinic acid in the light; only negligible amounts of succinic acid are formed in the dark. Apparently the photochemical cleavage of water provides the bacterial enzymes with the hydrogen which can otherwise be derived from gaseous hydrogen. When extracts of *E. coli* are mixed with "malic" enzyme, fumarase, green grana, TPN, and $MnCl_2$, small amounts of succinate are formed from pyruvate and CO_2 in the light. Under these conditions the malate formed via Reaction 9 is converted by the fumarase to fumarate, and the latter is reduced to succinate, as already mentioned. The net result is Reaction 13.

(13) $2\,H_2O + \text{pyruvic acid} + CO_2 \xrightarrow{\text{(light, TPN, } Mn^{++})} \text{succinic acid} + O_2 + H_2O$

The synthesis of carbohydrates may be coupled to the photochemical reduction of DPN. It was shown that phosphoglyceric acid could be reduced photochemically and converted to hexose diphosphate. In this experiment green grana were suspended in a solution of 3-phosphoglyceric acid, ATP, Bücher's transphosphorylating enzyme, triose phosphate dehydrogenase, triose phosphate isomerase, aldolase, DPN, and magnesium ions. Bücher's transphosphorylating enzyme catalyzes Reaction 14. DPN is reduced by the grana in the light (Reaction 8), and the $DPNH_2$ reduces the diphosphoglycerate to phosphoglyceraldehyde, a reaction catalyzed by triose phosphate dehydrogenase (Reaction 15). In the presence of triose phosphate isomerase some of the 3-D-phosphoglyceraldehyde is converted to phosphodihydroxyacetone (Reaction 16), and aldolase then catalyzes the condensation of the two triose phosphates to hexose diphosphate (Reaction 17). The net result of Reactions 14 to 17 when coupled to Reaction 8, is Reaction 18.

(14) 3-phosphoglyceric acid + ATP $\xrightleftharpoons{(Mg^{++})}$ 1,3-diphosphoglyceric acid + ADP

(15) $DPNH_2$ + 1,3-diphosphoglycerate $\rightleftharpoons$ 3-D-phosphoglyceraldehyde + DPN + $PO_4^{\equiv}$

(16) 3-D-phosphoglyceraldehyde $\rightleftharpoons$ dihydroxyacetone phosphate

(17) 3-D-phosphoglyceraldehyde + dihydroxyacetone phosphate $\rightleftharpoons$ fructose-1,6-diphosphate

(18) $2\,H_2O + 2$ 3-phosphoglycerate + 2 ATP $\xrightarrow{\text{(light, } Mg^{++}\text{, DPN)}}$ fructose-1,6-diphosphate + 2 ADP + 2 $PO_4^{\equiv}$ + O_2

No fructose diphosphate was formed in the dark.

Some of the intermediate steps in the biosynthesis of carbohydrates, proteins, and other compounds require phosphate-bond energy. This is exemplified by the conversion of 3-phosphoglycerate to hexose diphosphate, which needs ATP as a reactant (*cf.* Reaction 18). The conversion of light energy into the chemical energy of high-energy phosphate bonds may also be linked to the photochemical reduction of pyridine nucleotides, for the oxidation of $DPNH_2$ can generate energy-rich phosphate bonds according to Reaction 19 (*17*). The net result of Reactions 8 and 19 would be the photochemical formation of high-energy phosphate bonds (Reaction 20). Some evidence for the occurrence of Reaction 20 has recently been obtained in our laboratory.

TABLE 2

EVOLUTION OF OXYGEN DURING PHOTOCHEMICAL REDUCTION OF DPN*

Time (min)	Total amounts determined		Net production each 40 min		Ratio O_2/lactate
	Lactate	Oxygen	Lactate	Oxygen	
0	0.16	0.81			
40	0.55	0.99	0.39	0.18	0.46
80	0.95	1.23	0.40	0.24	0.60
120	1.26	1.36	0.31	0.13	0.42
				Av	0.49

* An aqueous suspension of green grana from spinach chloroplasts (containing 2.0 mg chlorophyll) was supplemented with DPN, pyruvate, and lactic dehydrogenase, and incubated at 15° C in an atmosphere of nitrogen for the time periods indicated. Values are expressed in micromoles.

(19) $DPNH_2 + \frac{1}{2}\,O_2 + 3\,ADP + 3\,PO_4^{\equiv} \rightarrow DPN + H_2O + 3\,ATP$

(20) $ADP + PO_4^{\equiv} \xrightarrow{\text{(light)}} ATP$

The reduction of pyridine nucleotides by green grana in the light, like the reduction of quinone, is accompanied by an evolution of oxygen. The oxygen evolution during the photochemical reduction of DPN in the presence of pyruvate and lactic dehydrogenase (Reactions 8 and 10) was determined through absorption of the oxygen by chromous chloride, and compared to the formation of lactate. The data in Table 2 show that oxygen evolution paralleled the formation of lactate, and that the oxygen/lactate ratio was that expected from Reactions 8 and 10.

The results that have been briefly summarized in this paper, as well as recent results of Tolmach (*18*) and Arnon (*19*) providing additional evidence for the photochemical synthesis of malate via Reaction 9, support the view that essentially the same mechanisms that function in the fixation of CO_2 in animal tissues and heterotrophic bacteria are operative in photosynthesis, with the difference that in heterotrophic organisms hydrogen and energy are furnished by oxidation of organic materials, whereas photosynthetic organisms utilize radiant energy to provide hydrogen through the splitting of water. It also appears that the reductive carboxylation of pyruvate to malate may actually be one of the steps in the path of CO_2 to carbohydrate and other foodstuffs during photosynthesis. In this connection Arnon's results (*19*) are of especial interest because the "malic" enzyme used in his experiments was isolated from the same leaves as the chloroplasts and shown to be present in the cytoplasmic fluid of the leaf cell rather than in the chloroplasts. The fact that most of the intermediate reactions in the oxidation of foodstuffs

are now known to be reversible suggests that photosynthesis may operate basically through reversal of a respiratory cycle which would be driven by radiant energy, a view supported by the work of Calvin and his collaborators (*20*).

Our experiments indicate that the photochemical reduction of coenzymes by green grana can mediate reductive carboxylations and other biochemical reductions through the action of well-defined respiratory and glycolytic enzymes that are common to all cells. The role of pyridine nucleotides as hydrogen acceptors in the photochemical reaction has been demonstrated by these experiments. The main task now will be to elucidate the mechanism by which the pyridine nucleotides and other coenzymes are reduced in the light. Similar mechanisms in chemosynthetic bacteria may couple the oxidation of hydrogen, sulfur, and ammonia to the reduction of pyridine nucleotides. The parallel study of photosynthetic and chemosynthetic organisms should further the understanding of the basic mechanisms of coenzyme reduction in autotrophic cells.

References

1. Werkman, C. H., and Wood, H. G. *Advances in Enzymol.*, **2**, 135 (1942).
2. Wood, H. G., *et al. J. Biol. Chem.*, **139**, 365, 377 (1941).
3. Evans, E. A., Jr., Vennesland, B., and Slotin, L. *Ibid.*, **147**, 771 (1943).
4. Moulder, J. W., Vennesland, B., and Evans, E. A., Jr. *Ibid.*, **160**, 305 (1945).
5. Ochoa, S., Mehler, A. H., and Kornberg, A. *Ibid.*, **174**, 979 (1948).
6. Ochoa, S., Veiga Salles, J. B., and Ortiz, P. J. *Ibid.*, **187**, 863 (1950).
7. Korkes, S., del Campillo, A., and Ochoa, S. *Ibid.*, 891.
8. Ochoa, S., and Kaufman, S. *Ibid.*, **192**, 313 (1951).
9. Conn, E., Vennesland, B., and Kraemer, L. M. *Arch. Biochem.*, **23**, 179 (1949).
10. Vennesland, B., Gollub, M., and Speck, J. F. *J. Biol. Chem.*, **178**, 301 (1949).
11. Ochoa, S. *Ibid.*, **174**, 133 (1948).
12. Hill, R. *Nature*, **139**, 881 (1937).
13. Ochoa, S. *Federation Proc.*, **9**, 551 (1950).
14. Vishniac, W. *Ibid.*, **10**, 265 (1951).
15. Vishniac, W., and Ochoa, S. *Nature*, **167**, 768 (1951).
16. ———. *J. Biol. Chem.* (in press).
17. Lehninger, A. L. *Ibid.*, **190**, 345 (1951).
18. Tolmach, L. J. *Nature*, **167**, 946 (1951).
19. Arnon, D. I. *Ibid.*, 1008.
20. Calvin, M., Bassham, J. A., and Benson, A. A. *Federation Proc.*, **9**, 524 (1950).

James Fitton Couch: 1888-1951

B. A. Brice

Eastern Regional Research Laboratory,
U. S. Department of Agriculture, Philadelphia, Pennsylvania

James Fitton Couch, eminent authority on poisonous plants and also on the flavonoid rutin, died on August 9, 1951, after a brief illness. He served for thirty-four years as a chemist in the U. S. Department of Agriculture. Born in Somerville, Massachusetts, he received degrees of A.M. from Harvard in 1913, A.M. and Ph.D. from American University in 1923 and 1926, and an honorary degree of Sci.D. from Philadelphia College of Pharmacy and Science in 1948. Although he was best known for his research and numerous publications in the field of phytochemistry, he was a penetrating student of philosophy and the history of science. He served part-time as professor of the history of science in National University, Washington, D. C., from 1928 to 1940.

During his twenty-three years' (1917–40) service with the Bureau of Animal Industry in Washington, D. C., he became well known for his investigations of stock-poisoning plants, such as loco weed, lupines, milkweed, larkspur, and white snakeroot. From the latter he isolated tremetol and showed that it was responsible for the disease known as milk sickness in domestic animals. He isolated and described many previously unknown poisonous substances occurring in plants.

In 1940 Dr. Couch joined the staff of the Eastern Regional Research Laboratory of the Department of Agriculture, as chemist in charge of the Tobacco Section. In the course of his work on the composition and utilization of tobacco, he isolated rutin and offered supplies of the pure compound to various physicians for clinical research, to determine whether it possessed activity in restoring increased capillary fragility and permeability to normal. After successful results were obtained, he established the buckwheat plant *Fagopyrum tataricum* as a domestic commercial source of the drug. Rutin is now widely used in the treatment of certain hemorrhagic disorders and conditions involving capillary fault, and considerable research is still in progress on the clinical and pharmacological evaluation of the flavonoids. The rutin development was recognized by the Department of Agriculture by presentation to Dr. Couch of its Distinguished Service Award in 1947. Dr. Couch and his collaborators also received awards for scientific exhibits on rutin from the Medical Society of the State of Pennsylvania in 1943 and 1946, and a certificate of merit from the American Medical Association in 1946.

Further recognition of his work on rutin came just prior to his death with the announcement that he had received the John Scott Award, comprising a medal

and premium, administered by the Board of Directors of City Trusts, City of Philadelphia. He thus entered the ranks of such recipients as Madame Curie, Thomas Edison, Orville Wright, Guglielmo Marconi, Alexander Fleming, C. F. Kettering, R. B. Woodward, Vannevar Bush, Irving Langmuir, C. E. K. Mees, J. J. Thomson, F. W. Aston, E. C. Kendall, Selman Waksman, and M. S. Karasch.

Dr. Couch was a member of the American Association for the Advancement of Science, the American Chemical Society, the American Institute of Chemists, the Pennsylvania Chemical Society, the Franklin Institute, the Pennsylvania Academy of Sciences, the New York Academy of Sciences, the Agricultural History Society, and the Philadelphia Organic Chemists' Club. He was a profound scholar and an enthusiastic research worker. His scientific ability, breadth of knowledge, personal integrity, and fine sense of humor won him the esteem and affection of many friends. His passing is a great loss to chemistry and agriculture, as well as to his colleagues and his numerous friends.

News and Notes

International Statistical Conferences

STATISTICIANS met for the first time in Asia in a series of International Statistical Conferences, which opened in New Delhi on December 5, 1951. Stuart A. Rice, president of the International Statistical Institute, presided. The President of the Republic of India inaugurated the meeting, and Prime Minister Pandit Nehru welcomed the delegates.

The International Statistical Conferences were the second largest world gathering of statisticians, the first being the one in Washington in 1947. The conferences were held from December 5 to 11 in New Delhi, and from December 16 to 18 in Calcutta. They were convened under the auspices of five international organizations, including the International Statistical Institute, the International Union for the Scientific Study of Population, and the International Association for Research in Income and Wealth. Delegates came from six Middle East countries, including Iran and Egypt, eight Far East nations, 16 European countries, Brazil, Chile, the U. S. and Canada, Australia, and Japan. Communist China was represented, but the countries behind the Iron Curtain were not. The delegates included representatives of the United Nations, ECAFE, FAO, UNESCO, WHO, and ILO. The host country, India, sent a strong delegation led by P. C. Mahalanobis, who was for the fifth time elected chairman of the UN Subcommission on Statistical Sampling. The delegates from the US included the 90-year old veteran Walter Willcox, Stuart A. Rice, M. A. Copeland, I. F. Corcoran, K. Davis, W. E. Deming, E. F. Dennison, A. Ross Eckler, Konard Becker, F. W. Lorimer, T. F. Mosimann, and W. F. Ogburn.

Dr. Rice said that serious limitations are imposed on the international development of statistics by the gulf between the Soviet and the non-Soviet concepts of statistics and by the withholding of available statistical data by various countries. He said that the United States had made available information requested by the United Nations and intergovernmental organizations for international publications, and he pointed out that underdeveloped countries of the East have fully recognized the vital need for the acquisition of statistics.

The orbit of the conferences was amazingly vast. The national statistical systems of the participating countries were discussed at a separate meeting, with W. R. Leonard in the chair; and reports on the internal statistical systems of Federal Germany, Japan, and India were presented. Emile Borel, leader of the French delegation, detailed the role of statistics in government administration. In population statistics, technical committees under Professor Willcox dwelt at length on the accuracy of demographic and census data. Papers on the statistical study of birth rates, variation of sex ratio in different conditions, and a study on the fertility ratio and age at marriage merit special mention. Industrial, labor, and agricultural statistics loomed large in the discussions. W. E. Deming, statistical adviser to the U. S. Bureau of the Budget, said that sampling methods in industry had increased production, and he emphasized the need for standardization of products. The role of quality control, business research, and observation in the increase of production was stressed by H. C. Hamakar (Netherlands), I. H. C. Tipper (U.K.), and A. Linder (Switzerland). The ILO Seminar on Labour Statistics continued its deliberations, focusing attention on the need for compilation of reliable labor statistics for Asian countries and for special methods of statistical inquiry into the problems of consumption and underemployment.

The computation of national income and wealth, statistical education, and the report of the Statistical Education Committee of the International Statistical Institute were also considered. The principal Indian delegate stressed the role of mathematical statistics in secondary education and professional training. The problem of teaching statistics in South East Asia was also covered. In statistical sampling, the U. S. subcommission considered the use of survey and experimental techniques for the development of agriculture and small-scale industries. The delegates had the opportunity of getting firsthand information on a new statistical project, an inquiry into rural economic con-

ditions. The inquiry is being conducted by the National Sample Survey, which has already investigated about 1800 Indian villages and 60 urban areas.

In view of the mounting recognition of, and need for, statistics in the countries of Asia, the delegates from Asian countries recommended the establishment of a special body of Asian statisticians. The participation of the governments of this region and procedural matters relating to the formation of this new body have been considered.

N. R. SRINIVASAN

Indian Institute of Science
Bangalore

Scientists in the News

James E. Ablard has been named deputy chief of the Explosives Research Department, Naval Ordnance Laboratory, to succeed **Paul F. Fye,** who has been made department chief. Dr. Ablard came to NOL in 1949, and upon the reorganization of the Research Department in 1950 he became chief of the Explosives Properties Division.

Louis C. Barail, who has been chief biologist-bacteriologist of the U. S. Testing Co. for the past eleven years, is now a private consultant to industry in biochemistry and toxicology, with offices in New York City and Hackensack, N. J.

Henry K. Beecher has recently been named an honorary member of the Royal Society of Medicine (London) "for services to science."

Hermann M. Burian, formerly of Boston, has joined the staff of the Department of Ophthalmology, College of Medicine, State University of Iowa, as an associate professor.

Charles M. Carrier has been elected vice president and manager of manufacturing for the Great Northern Paper Company, succeeding **C. B. Stanwood** who resigned from these offices, but will remain with the company as director of purchasing. Mr. Carrier has been with the paper company 36 years, having started as a chemist.

Kenneth E. Caster, associate professor of geology at the University of Cincinnati, has received notice of his election to membership in the Brazilian Academy of Science at the meeting of its General Assembly in Rio de Janeiro. At the request of the U. S. State Department and the president of Brazil, Dr. Caster went to Brazil in 1945 as visiting professor and director of the Department of Geology and Paleontology at the University of São Paulo. Before returning to Cincinnati in 1948 he conducted intensive South American paleontological investigations as a Guggenheim fellow.

Leo Otis Colbert has been appointed director of the Washington office of the Arctic Institute of North America. Admiral Colbert, who retired as director of the U. S. Coast and Geodetic Survey after more than 40 years of service, will take over the duties of **A. L. Washburn,** who resigned recently to enter government service. The institute maintains offices in Montreal, New York, and Washington, and is affiliated with the National Academy of Sciences, the National Research Council, and the AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. It was founded in 1945 by U. S. and Canadian scientists who recognized the need for a coordinated study of the northern reaches of the continent. Since then it has sponsored nearly 90 field research projects in the North American Arctic and Subarctic.

Paul W. Dieckman, former vice president of Wagner College, Staten Island, N. Y., has been elected president of Midland College, Fremont, Neb., succeeding **William P. Hieronymus,** whose resignation will be effective on June 1.

Fritz John has returned to his position as professor of mathematics at New York University after serving one year as director of the National Bureau of Standards Institute for Numerical Analysis at UCLA. His successor at UCLA was **Derrick H. Lehmer,** of the University of California at Berkeley.

Willard Frank Libby, of the University of Chicago, has been selected for the 1951 Research Corporation Award for developing the technique of radiocarbon dating. Research Corporation, New York, was established in 1912 by Frederick Gardner Cottrell as a nonprofit foundation to distribute grants-in-aid of research to colleges, universities, and scientific institutions. Dr. Libby's award, consisting of a plaque, citation, and $2500, was presented by Joseph W. Barker, president and chairman of the board.

G. Burroughs Mider has been appointed scientific director at the National Cancer Institute of the National Institutes of Health. Dr. Mider is professor of cancer research and coordinator of cancer teaching in the School of Medicine and Dentistry at the University of Rochester. He will be responsible for the intramural research of the National Cancer Institute. Dr. Mider is a member of the Board of Directors of the New York State Division of the American Cancer Society and a consultant to the Rochester Laboratories of the AEC.

Charles M. Pomerat, professor of cytology and director of the Tissue Culture Laboratory at the University of Texas Medical Branch, Galveston, is visiting European cytology research centers for the purpose of reporting current advances in tissue culture study, and of correlating European contributions, for service to American workers in the field. Dr. Pomerat will visit medical laboratories in Paris, Milan, Zurich, Basel, Strasbourg, and Cambridge.

Abdul Rashid Quraishi, Assistant Surveyor General of Pakistan, is visiting the U. S. to study topographic mapping techniques.

José Raymundo de Andrade Ramos, mining engineer

with the Divisão de Geologia e Mineralogia, National Department of Mineral Production, Brazil, is in this country to continue his studies in stratigraphical geology and invertebrate paleontology, with special reference to the mollusks.

Soon Sein, a native of Burma and a graduate student at the Colorado School of Mines, visited the Exploration Engineering Unit of the Geologic Division, U. S. Geological Survey at Denver, Colo., to learn about the exploration work on the Colorado Plateau currently being done by the Survey. Mr. Sein expects to return to Burma in September to take an active part in mineral exploration for the Burmese Geological Survey and Bureau of Mines.

Norman A. Shepard, of American Cyanamid Company, has been appointed chairman of a Committee on Materials of the Department of Defense Research and Development Board. The new committee will have jurisdiction over materials matters formerly handled by various RDB committees, including the former Equipment and Materials Committee, which has been reconstituted the Committee on Equipment and Supplies. Dr. Shepard joined the staff of American Cyanamid Company as director, technical service, in 1936, and since 1941 has held the position of director of chemical research. From 1943 to the present time, Dr. Shepard has been a member of the advisory committee for Quartermaster Research and Development, NRC. The new RDB committee will have as executive director **John H. Garrett,** a member of the RDB secretariat since 1949 and a former deputy executive director of the Equipment and Materials Committee. **Nathaniel C. Fick,** an RDB staff member since 1948, will serve the new committee as director of the Panel on Metals and Minerals.

Emily Myrtle Smith and **Genevieve Soller,** of the U. S. Public Health Service, have been assigned to Formosa and the Philippines under the Mutual Security Agency program. Miss Smith will be stationed in Taipeh, and Mrs. Soller in Manila. They will be chief nurse consultants to the MSA missions in these two capitals.

Heinz Steinitz, who has been appointed Magnes fellow, Department of Zoology, Hebrew University, Israel, is spending the year in the Department of Anatomy, Yale University School of Medicine, carrying on a research project on the retina with L. S. Stone.

Jeffries Wyman and **Leonard J. Eyges** will serve as science attachés at the American Embassy in Paris. The appointments follow the assignment last summer of science attachés to American missions at London, Stockholm, and Bern. Appointments of scientists to other missions abroad are expected to be made. Dr. Wyman was until recently associate professor of biology and director of the Biological Laboratory at Harvard University. Dr. Eyges, a physicist, has been engaged in research and teaching at the University of California.

Education

The **Biological Laboratory** of the Long Island Biological Association, Cold Spring Harbor, is offering the following specialized courses: Bacterial Viruses (June 23–July 12), under the direction of A. H. Doermann; Bacterial Genetics (July 16–Aug. 5), given by E. M. Witkin, V. Bryson, M. Demerec, and staff; Cytology of Microorganisms (Aug. 11–30), by E. D. DeLamater; and Population Genetics (June 23–July 31), by R. P. Levine. Further information may be obtained from the laboratory.

Columbia University, Presbyterian Hospital, and the **Institute for the Crippled and Disabled** have signed an affiliation agreement, retroactive to Jan. 1, to undertake a comprehensive program of medical care, physical and social readjustment, and job placement of the handicapped. The three groups will operate on their separate budgets, but the work will be coordinated and supervised by Robert C. Darling. Research aimed at the development of new and improved prosthetic devices will be emphasized.

The **Los Angeles College of Optometry** will hold a special summer session May 26–June 6, open to certified optometrists and others interested in visual science or physiological optics. Information may be obtained from Monroe J. Hirsch, 950 W. Jefferson Blvd., Los Angeles.

At **Loyola University** the master of science program in chemistry, discontinued during World War II, has been re-established. The faculty is being expanded, and new research laboratories are being constructed. It is hoped that eventually the Ph.D. with a major in chemistry will also be offered. Applications for assistantships should be directed to R. P. Mariella, chairman of the department.

The annual **National College Chemistry Testing Program** will be conducted this spring by the Examinations Committee of the Division of Chemical Education of the American Chemical Society. As in past years, objective tests are available in qualitative and quantitative analysis, organic and physical chemistry, and biochemistry, as well as a new examination in general chemistry. A bulletin describing the tests may be obtained from T. A. Ashford, Chairman, Examinations Committee, St. Louis University, St. Louis, Missouri.

Sponsored by the **Wool Bureau Incorporated,** a regional seminar seeking to determine methods of adequately informing the American consumer regarding quality of fabric and construction of clothing was held at Teachers College, Columbia University, last month. It is hoped that home economics departments in other institutions will be able to hold similar seminars, and a textbook is being planned on the subject. Panel members included Jules Labarthe, Jr., Giles E. Hopkins, Ruth Jackendoff, William Beer, Ephraim Freedman, Richard S. Lees, and Stanley Bernstein.

Grants and Fellowships

The 1952–53 **American Council of Learned Societies** awards for study or research are open to teachers in the humanities temporarily displaced from college and university faculties as a result of the defense emergency. Candidates must be U. S. citizens, or must have officially declared their intention of becoming citizens, and the latter must have taught at least three years in a U. S. college or university. The stipend will normally be the equivalent of the salary earned by the candidate during the most recent academic year in which he taught, but not to exceed $5000. No allowance will be made for foreign travel. For application forms (returnable by *May 15*), write immediately to ACLS Scholars, 1219 Sixteenth St., N.W., Washington 6, D. C.

The **Ford Foundation** has made initial grants of $6,550,000 to promote rural and industrial development in Pakistan and India. Included in the grants is $500,000 to help establish a women's college for domestic science and teacher training in Pakistan.

The closing date for applications for awards under the **Fulbright Act** for university lecturing and postdoctoral research in 1953–54 in East Asia and the Pacific is *Apr. 15*. Special interim programs are also available in Denmark, Iraq, Pakistan, and Japan. In addition, there are a number of openings in the 1952–53 program for Pakistan, announced last year. For full information, write at once to Committee on International Exchange of Persons, 2101 Constitution Ave., Washington 25, D. C.

Pennsylvania State College has received securities worth $27,500 from John P. Herrick, oil producer, to finance two scholarships in geology, mineralogy, or engineering in memory of E. L. Drake, who drilled the first oil well in the U. S., near Titusville, Pa., 92 years ago. One scholarship will go to a resident of the state and one to a nonresident.

Meetings and Elections

The **American Fern Society** elected the following officers at its annual meeting: president, Ralph C. Benedict; vice president, Donovan S. Correll; secretary, Warren H. Wagner, Jr.; treasurer, M. D. Mann, Jr. A. C. Smith was added to the staff of editors of the *American Fern Journal*, the continuing editors of which include C. V. Morton, Ira L. Wiggins, and Dr. Benedict. Rolla M. Tryon, Jr., is librarian and curator of the herbarium.

Meetings of the **Society of Clinical Surgery, the Society of University Surgeons,** and the **Halsted Club** were held in February at Johns Hopkins Hospital to observe the centennial of the birth of William S. Halsted. Exhibits of Halsted's scientific papers, surgical equipment and instruments, and personal belongings, scientific sessions, and a dinner were features of the celebration. Speakers at the banquet included René Lerich, of the Collège de France, Allen O. Whipple, of Princeton, and David H. Patey, British representative of the Royal Society of Medicine and the Royal College of Surgeons. Alfred Blalock presided at the banquet, and Emile Holman was chairman of the Centennial Committee.

A **Symposium on Climatic Changes** will be held May 9–10 at the American Academy of Arts and Sciences, Boston. "Sources of Climatic Change," "Record of Climatic Changes," and "Climate and Man," will be among the topics covered. "Climatic Requirements on This and Other Planets for the Origin and Continuity of Life" will be discussed by a panel of experts from astronomy, biophysics, physiology, oceanography, and paleontology. Harlow Shapley is chairman of the symposium committee.

Miscellaneous

The Astrophysical Journal, a University of Chicago Press publication since 1895, will now be published under the joint sponsorship of the Press and the American Astronomical Society. W. W. Morgan and S. Chandrasekhar, both of Yerkes Observatory, will remain in their former positions of managing editor and associate editor, respectively. The society has appointed Paul W. Merrill, Lyman Spitzer, Jr., Fred Whipple, C. D. Shane, and Gerhard Herzberg to the editorial board, on which the two editors are the Press representatives.

The **Fish and Wildlife Service** has consolidated the three research units now working on Pacific salmon into one unit, with headquarters in Seattle. The new Pacific Salmon Investigations unit will be headed by Clinton E. Atkinson, head of the research program on shad and Atlantic salmon at Beaufort, N. C. His assistant will be Clifford J. Burner, present chief of the North Pacific Fishery Investigations.

Newly appointed members of the **National Science Foundation** Divisional Committee for Mathematical, Physical, and Engineering Sciences are: A. A. Albert, Jesse W. Beams, W. L. Everitt, Leo Goldberg, M. P. O'Brien, G. P. Pegram, C. C. Price, W. W. Rubey, C. S. Smith, S. S. Wilks, and E. B. Wilson, Jr.; and of the Divisional Committee for Biological Sciences, Marston Bates, G. W. Beadle, D. P. Costello, W. O. Fenn, Jackson Foster, Theodor Just, J. S. Nicholas, H. B. Vickery, and Douglas M. Whitaker. The committees have been established to serve in an advisory capacity on questions relating to major activities of the foundation.

The **William Osler Medal** has been established by the American Association of the History of Medicine to stimulate interest and research in medical history. Unpublished essays by men or women who are predoctoral students in schools of medicine at the time the essays are written will be considered, and preference will be given to accounts of original research. Essays should be submitted before *Apr. 15* to Benjamin Spector, Tufts Medical School, 136 Harrison Ave., Boston 11.

Technical Papers

Relation of Prothrombin to the Prolongation of Clotting Time in Aestivating Ground Squirrels

Arthur Svihla, Howard Bowman, and Ruth Ritenour[1]

Department of Zoology, University of Washington, Seattle

A change in the blood clotting time was found to take place in two species of ground squirrels (*Citellus columbianus* and *C. parryi ablusis*) when these mammals are in a dormant state during either aestivation or hibernation. A complete clot did not form even when the blood sample was exposed to the air for several days (*1*). Although blood clotting has been studied intensively for a long time, this phenomenon is still imperfectly known. The most generally accepted theory of blood coagulation, as formulated by Morawitz (*2*), includes these steps:

1. Prothrombin (plasma factor) + calcium ions + thrombokinase (thromboplastin, tissue and platelet factor) = thrombin.
2. Thrombin + fibrinogen = fibrin.

The first equation has recently been modified by Owren (*3*), Ferguson (*4*), and Quick (*5*), but essentially the above-mentioned components of the blood are necessary for the formation of a clot. The decrease of any of these substances may prolong clotting time or completely inhibit clot formation. This has been shown in the classic work of Campbell, Link, *et al.* (*6*) in their investigation of the hemorrhagic diseases of such domestic animals as sheep and cattle, which became hemophilic when fed moldy sweet clover hay and died of internal hemorrhages. Link (*7*) found that this hemophilic condition was brought about by the destruction of the prothrombin in the blood by the substance coumarin, which is present in large amounts in moldy sweet clover hay. Previously, Quick (*8*) found that laboratory rabbits that were fed moldy sweet clover hay became hemophilic and bled to death when their hearts were punctured with a hypodermic needle.

Similarly, our ground squirrels developed a pericarditis when the heart was punctured while they were dormant. This did not occur when they were normal and active. This seasonal hemophilic condition in ground squirrels might be considered as caused by decreased amounts of various blood substances such as (*a*) prothrombin, (*b*) thromboplastin, (*c*) calcium, (*d*) fibrinogen, as well as (*e*) the possible presence of an anticoagulant. It was therefore determined to test for the amounts of each of these substances in the blood of both active and dormant squirrels. This report concerns the relationship of prothrombin to the prolongation of clotting time in these animals.

Quick (*9*) has developed a technique to determine the amount of prothrombin in the blood by diluting the blood and supplying ample amounts of all other components such as thromboplastin, calcium, etc., and then recording the coagulation time. Any decrease in the amount of prothrombin in the blood sample is indicated by the increase in clotting time. In our experiments we followed Kato's modification (*10*) of Quick's technique, since less blood is required, and used commercial thromboplastin manufactured by Difco Laboratories. Table 1 and Fig. 1 show our results.

TABLE 1

CLOTTING TIMES AT DIFFERENT PROTHROMBIN CONCENTRATIONS

	Active animals						Dormant animals				
	10	20	30	50	100		10	20	30	50	100
	65.5	34.4	25.0	20.9	19.7		104.0	68.4	61.3	44.4	30.0
	60.7	27.3	23.2	22.2	21.7		541.0	78.4	55.1	26.5	25.3
	134.6	65.0	45.2	27.8	21.1		61.2	39.9	33.1	25.3	25.3
	61.2	31.3	26.4	19.6	18.5		256.0	58.2	74.9	27.2	23.5
	81.8	48.5	26.8	20.1	16.0		95.0	63.5	35.5	27.6	25.0
	69.0	38.4	32.7	22.1	20.2		70.0	42.7	27.2	25.3	20.1
	64.8	40.5	28.8	19.7			243.0	41.4	30.6	25.6	20.2
Av	76.5	40.7	29.7	21.7	19.5 sec		105.0	49.2	40.0	29.9	24.5
							92.0	44.2	34.2	19.6	18.7
								56.2	43.0	33.1	20.1
						Av	174.1	54.2	43.5	28.5	23.3

A reduction in the amount of prothrombin in the blood of dormant squirrels is apparent. At all concentrations of prothrombin used, the clotting times were much longer for the dormant animals than for the active ones. For the latter, the normal blood or that with 100% concentration of prothrombin shows an average clotting time of 19.5 sec, whereas the blood of the dormant squirrels at the same concentration clots on an average of 23.3 sec. At lesser concentra-

[1] Acknowledgment is hereby made to the Air Force under Contract AF 33 (038)-18509 for aid and assistance in carrying out this study.

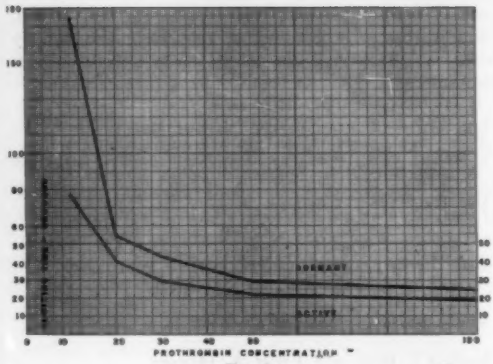


FIG. 1.

tions—for example, 10%—a much greater disparity in clotting times occurs, for now the blood of the active animals clots on an average of 76.5 sec, whereas that of the dormant squirrels requires an average of 174.1 sec.

Percentages of prothrombin dilutions may be compared by either of two methods that are in general use. The following formula of Ziffren *et al.* (*11*) is the one commonly used in clinics:

$$\text{Prothrombin percentage} = \frac{\text{average normal prothrombin time}}{\text{prothrombin time of patient}} \times 100.$$

Applying this formula to our data, we obtain a prothrombin percentage of 83.6 for dormant ground squirrels.

The second method for obtaining prothrombin dilutions is the use of a correlation chart, as employed by Nygaard (*12*). He has pointed out that more accurate results are obtained by this method. Quick (*13*) has also shown the fallacy of using Ziffren's formula, since the relation of clotting time to concentration of prothrombin is not linear but expressed by a hyperbolic curve. According to Nygaard's correlation chart, the prothrombin dilution for our dormant ground squirrels would be approximately 38%. This we take to be the more accurate percentage.

It is now well known that in the case of persons who are bedridden for any length of time, thromboses are apt to form, especially in lower extremities, as a result of lack of proper circulation. Post-operative cases are therefore encouraged to become ambulatory as soon as possible in order to stimulate circulation and thus prevent the formation of the thromboses. Seasonal changes in the blood picture of ground squirrels may be conceived as being an efficient adaptation to the dormant state. During this period the rate of blood flow is greatly reduced, thus increasing the danger of clots forming in the blood stream and causing death. A decrease in the amount of prothrombin during dormancy hence alleviates any danger of thrombus formation due to the lowered rate of blood circulation at this time. The same principle of decreasing the amount of prothrombin in the blood of humans is utilized in dicumarol therapy.

References

1. SVIHLA, A., BOWMAN, H., and RITENOUR, R. *Science*, **114**, 298 (1951).
2. MORAWITZ, P. *Beitr. Chem. Physiol. Path.*, **5**, 133 (1904).
3. OWREN, P. A. *Acta Med. Scand.*, **128**, Suppl. No. 194, 1 (1947).
4. FERGUSON, J. H. *Am. J. Med.*, **3**, 67 (1947).
5. QUICK, A. J. *Ann. Rev. Physiol.*, **12**, 237 (1950).
6. CAMPBELL, H. A., *et al. J. Biol. Chem.*, **138**, 1, 513 (1941).
7. LINK, K. P. *Ibid.*
8. QUICK, A. J. *Am. J. Physiol.*, **118**, 260 (1937).
9. ———. *Proc. Soc. Exptl. Biol. Med.*, **42**, 788 (1939).
10. KATO, K. *Am. J. Clin. Path.*, **10**, 147 (1940).
11. ZIFFREN, S. E., *et al. Proc. Soc. Exptl. Biol. Med.*, **40**, 595 (1939).
12. NYGAARD, K. K. *Hemorrhagic Diseases*. St. Louis: Mosby (1941).
13. QUICK, A. J. *The Physiology and Pathology of Hemostasis*. Philadelphia: Lea & Febiger (1951).

Manuscript received October 22, 1951.

Inactivation of Influenza Virus and of Viral Hemagglutinin by the Ciliate *Tetrahymena geleii*[1, 2]

Vincent Groupé and Leonora H. Pugh

Department of Microbiology, New Jersey Agricultural Experiment Station, New Brunswick

The experiments described in this report were undertaken to determine what effect, if any, the influenza virus and the free-living ciliate *Tetrahymena geleii* might have upon each other. Bacteria-free cultures of *T. geleii*[3] were propagated in 1.0% proteose peptone broth (Difco) at 28° C. Egg-adapted strains of influenza A (PR-8 strain) and influenza B (Lee strain) virus were cultivated in the allantoic sac, and allantoic fluid was collected 48 hr after infection from viable embryos. Hemagglutination tests (*1*) and infectivity titrations (*2*) were performed in the usual manner. Aseptic precautions were taken in all experiments.

In the experiments described below a constant amount of influenza B virus (10% by vol of infected allantoic fluid) was added to varying concentrations of viable and killed (frozen and thawed) cultures of *T. geleii*, respectively, as indicated in Table 1. The protozoal cultures used were previously incubated for 7–9 days at 28° C to ensure maximum growth. Samples were taken from each of the various cultures[4] at intervals during the incubation period, and hemagglutinin and infectivity titers were determined. Formalin, in amount sufficient to make a final concentration of 0.05%, was added to all samples used in hemagglutination tests to kill the protozoa. Samples used for infectivity titrations were serially diluted without treatment of any kind and inoculated into

[1] Paper of the Journal Series, New Jersey Agricultural Experiment Station, Rutgers University—The State University of New Jersey—Department of Microbiology.

[2] These studies were supported by grants-in-aid from the Kresge Foundation and the Rutgers Research and Endowment Foundation.

[3] Bacteria-free cultures of *T. geleii* were obtained through the courtesy of George W. Kidder.

[4] A total volume of 100 ml of culture medium containing protozoa and virus was placed in each of a series of Blake bottles and incubated in the horizontal position at 28° C.

TABLE 1

EFFECT OF *Tetrahymena geleii* ON INFLUENZA B VIRUS

Protozoal culture*	Viral hemagglutinin titer			Infective titer (ID_{50})
	Hr incubation at 28° C			
	0	24	48	48
None	64†	32	32	$10^{-6.5}$
Viable				
Undiluted	32	32	64	$10^{-2.7}$
½‡	32	32	16	
1/20	32	32	1	$10^{-4.5}$
Killed (frozen and thawed):				
Undiluted	32	32	32	$< 10^{-1.0}$
½	32	32	32	
1/20	32	32	32	$10^{-4.6}$

* Previously incubated 7–9 days at 28° C.
† Reciprocal of hemagglutinin titer of culture.
‡ Diluent used was 1% proteose peptone medium.

groups of 5 eggs each. Macroscopic and microscopic examination of the cultures at various intervals indicated that the presence of virus did not affect either the motility of the protozoa or their rate of multiplication. Little or no gross change in the concentration of protozoa was observed in mature undiluted cultures in the presence or absence of virus. However, the virus was affected in several ways by the protozoal culture.

The data from a typical experiment are summarized in Table 1. When the infective titers of the various cultures are compared after 48 hr of incubation it is evident that both viable and killed cultures of *T. geleii* contained a factor which inactivated influenza B virus. Protozoal cultures, killed by freezing and thawing, were found to be slightly more effective than viable cultures. Dilution of the protozoal cultures was accompanied by diminished viral inactivation. These data recall to mind the fact that antibacterial lipids have been obtained from similar cultures of *T. geleii* (*3*). Further inspection of the data indicates the existence of another phenomenon. It will be seen that viral hemagglutinin was markedly reduced by diluted, actively multiplying, viable protozoal cultures, whereas killed cultures or undiluted, mature, viable cultures had no effect on viral hemagglutinin. Identical end points (1/320) were obtained when viral hemagglutinin was titrated in the presence of culture medium from young (3-day) protozoal cultures, fresh broth, and saline, respectively. It is clear, therefore, that viral hemagglutinin, representing both infective and noninfective virus particles, was inactivated or destroyed only by actively multiplying (i.e., diluted) protozoal cultures. Similar results were obtained in comparable experiments with influenza A virus. It is well known that *T. geleii* and other ciliates feed upon certain bacteria and it would appear that a similar mechanism obtains in the case of the influenza viruses.

The influenza viruses, then, do not affect *T. geleii*, but the protozoal culture may affect the virus in at least 2 ways: first, viral inactivation by a factor present in both killed and viable cultures, and, second, inactivation or destruction of viral hemagglutinin by actively multiplying but not by mature protozoal cultures.

References

1. HIRST, G. K. *J. Exptl. Med.*, **91**, 161 (1950).
2. ———. *J. Immunol.*, **45**, 285 (1942).
3. MCKEE, C. M., *et al. Proc. Soc. Exptl. Biol. Med.*, **65**, 326 (1947).

Manuscript received October 22, 1951.

The Importance of Protective Urinary Colloids in the Prevention and Treatment of Kidney Stones

Arthur J. Butt and Ernst A. Hauser

Butt-Douglas Medical Foundation, Pensacola, Florida, Massachusetts Institute of Technology, Cambridge, and Worcester Polytechnic Institute, Worcester, Massachusetts

A calculus is generally defined as a concentration formed of crystalloids (*1*) held together by, and incorporated in, a colloidal matrix. The formation of urinary calculi is, however, far more complex and is still not fully understood (*2–6*).

Most investigations concerning the prevention and treatment of kidney stones have so far been directed only toward trying to ascertain how the concentration of crystalloids excreted in the urine could be diminished. With the exception of correcting certain metabolic disorders, all attempts to control calculous formations have so far not proved entirely successful. The influence that hydrophilic colloids exert in the etiology of kidney stone formation and prevention has never received sufficient attention. We therefore felt that a more systematic study of the action of hydrophilic colloids might offer valuable information on how the formation of urinary concretions could be completely avoided or at least stopped. Such knowledge might even lead to the development of a more efficient method by which some stones could be removed without surgery.

From a colloid-chemical point of view urine must be considered as a supersaturated solution of extremely complex composition. The electrolytes and nonelectrolytes in the urine of a healthy person remain in solution at a much higher concentration than their solubility in pure water would indicate; this is due to the presence of protective colloids. This fact was stated by Lichtwitz some time ago (*4, 5*). Ord (*6*) and Rainey (*7*) had already observed that crystals formed from solutions containing hydrophilic colloids differed pronouncedly in their morphology and properties from those derived from pure aqueous solutions. To Ebstein (*2*) must go the credit for having been the first to draw attention (in 1884) to the importance of colloids in kidney stone formation. Since then much research pertaining to the etiology of stones has referred to an "unbalance" of colloids and crystalloids, but there is a serious lack of infor-

mation concerning further work on this phenomenon.

It would seem that colloids are a very important, yet often neglected, factor which deserves far more attention than it has received so far in the study of stone formation and prevention. We therefore decided to study systematically the concentration of hydrophilic colloids in the urine of several hundred individuals, both males and females, of various races, living in different climates, and to correlate the results with the occurrence of kidney stones in these individuals. These tests were carried out on various islands in the Pacific Ocean and also in west Florida, which is recognized as an area of high stone incidence (*8–10*).

Systematic colloid-chemical studies, which included surface tension determination, ultramicroscopic investigation, determination of electric charges carried by the colloidal particles visible in the specimens, and chemical analysis of the urine samples offered definite proof that the urine of individuals giving evidence of stone formation was deficient in protective colloids, and that this was the main factor in stone formation. As a matter of fact, it could be ascertained that the incidence of stones in both sexes in different ethnic groups and nationalities is inversely proportional to the protective urinary colloids present. It was also found that the urine of females generally has a higher concentration of hydrophilic colloids than that of males. It was also demonstrated that the concentration of ultramicroscopically visible protective colloid particles in the urine of pregnant women is larger than that in the urine of nonpregnant women.

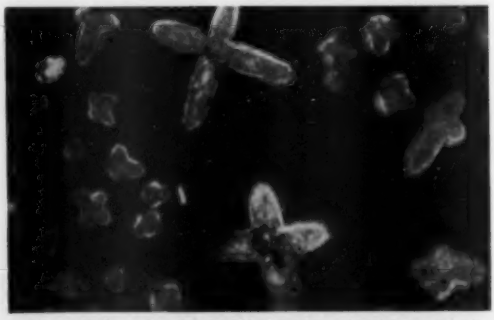


FIG. 1. Urine passed by patient prior to treatment. Photo-ultramicrograph of extremely alkaline urine of white male due to urea-splitting organisms. Multiple bilateral rapidly recurring stones. × 1200.

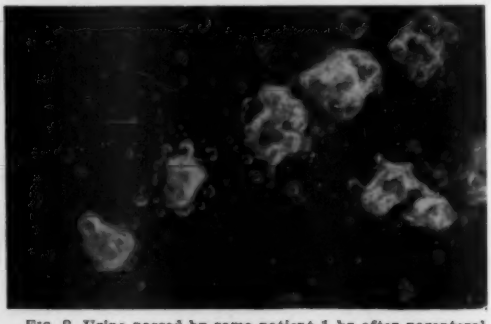


FIG. 2. Urine passed by same patient 1 hr after parenteral injection of 300 TRU of hyaluronidase mixed with physiological saline. × 1200.

All surface tension determinations were carried out by the pendent drop method (*11*), the only method that can offer reliable results when studying solutions as complex as urine. The results obtained with the urine of white females gave an average of 60 dynes/cm, whereas the average with specimens from Negro females amounted to only 52 dynes/cm. In contrast, the corresponding figures for males were 65 and 55 dynes/cm, respectively. The surface tension of specimens from a Negro female dropped from 52 to 42 dynes/cm from her second to her seventh month of pregnancy.

The correlation of these results with the tendency to stone formation would indicate that from a colloid-chemical point of view the presence of capillary-active agents might be the predominant factor because of their action as protective colloids and dispersing agents, forming a reversible gel in combination with the crystal micelles, instead of permitting the micelles to grow into solid crystals of inorganic matter.

It was therefore decided to ascertain whether the concentration of protective urinary colloids could be increased by parenteral injections of a potent protective colloid and dispersing agent. From a biochemical point of view the injection of Wydase® (150 TRU)[1] dissolved in 1 ml saline solution seemed to be of special interest because of its high capillary activity and pronounced protective action. This preparation is hyaluronidase, an enzyme with a fairly high molecular weight. Hyaluronic acid, one of the two substrates of hyaluronidase, is a complex mucopolysaccharide compound, of very high molecular weight, composed of alternating units of acetyl glucosamine and glucuronic acid. Extensive ultramicroscopic studies had already offered visual proof that it is the hyaluronic acid component which acts as a strong peptizing agent and protective colloid. Figs. 1 and 2 offer visual evidence both of the effectiveness of injecting the enzyme as produced by the Wyeth Institute of Applied Biochemistry and of its action.

We feel that this discovery of the action protective colloids exert in preventing the formation or development of stones might well open up a new and hitherto neglected field for medical science far beyond the treatment for kidney stones. This statement is based on recent observations which indicate that the formation of protective colloids in the human body virtually disappears during times of strong emotional stress.

Urine is a highly concentrated solution due to the presence of certain colloids. The protective action of urinary colloids is of major importance in preventing

[1] One TR (turbidity-reducing) unit of hyaluronidase is the amount which will, in 30 min, reduce the turbidity produced by 0.2 mg hyaluronic acid (mixed with acidified serum) to that produced by 0.1 mg, under standard conditions.

precipitation, agglomeration, and conglomeration of crystalloids from such a solution.

If the concentration of such protective colloids is insufficient, stone formation begins or is accelerated. In 680 subjects the incidence of stone was found to be almost inversely related to the degree of protective urinary colloids present.

Subcutaneous injection of hyaluronidase (mixed with saline) causes a pronounced increase in protective urinary colloids. The colloids may form a gel and thereby prevent crystallization of the electrolytes present. They act as excellent dispersing agents, preventing the formation of stones.

Hyaluronidase therapy has been effective in preventing the formation or recurrence of urinary calculi over a period of 11–15 months in 18 of 20 patients with a tendency to rapid stone formation.

References

1. HAUSER, E. A. *Colloidal Phenomena.* New York : McGraw-Hill (1939).
2. EBSTEIN, W. *Die Natur und Behandlung der Harnsteine.* Wiesbaden : Steinkopff (1884).
3. JOLY, J. S. *Stone and Calculous Diseases of the Urinary Organs.* St. Louis : Mosby (1940).
4. LICHTWITZ, L. In Kraus and Brugsch (Eds.), *Spezielle Pathologie und Therapie, innerer Krankheiten,* Vol. I. Berlin : Urban and Schwartzenberg (1919).
5. ———. In J. Alexander (Ed.), *Colloid Chemistry,* Vol. V. New York : Reinhold (1944).
6. ORD, W. M. *Quart. J. Microscop. Sci.,* **12**, New Ser., 41 (1872).
7. RAINEY, G. *Ibid.,* **6**, 41 (1858).
8. BUTT, A. J. *J. Florida Med. Assoc.,* **37**, 711 (1951).
9. ———. Role of Protective Urinary Colloids in Prevention of Urinary Calculi. Paper read at annual mtg. Southeastern Section, Am. Urol. Assoc., Memphis, Tenn., March 1951. (To be published.)
10. BUTT, A. J., and HAUSER, E. A. Importance of Urinary Colloids in Kidney Stone Prevention. Paper read at 25th National Colloid Symposium, Cornell Univ., Ithaca, N. Y., June 21, 1951.
11. ANDREAS, J. M., HAUSER, E. A., and TUCKER, W. P. *J. Phys. Chem.,* **42**, 1001 (1938).

Manuscript received October 18, 1951.

Multicurie Cobalt 60 Units for Radiation Therapy

A. Morrison, W. R. Dixon, C. Garrett, H. E. Johns,[1] L. M. Bates, E. R. Epp, D. V. Cormack, and S. O. Fedoruk

Radiology Laboratory, Division of Physics, National Research Council of Canada, Ottawa, and Physics Department, University of Saskatchewan, Saskatoon

One of the fundamental objectives in the use of radiation in cancer therapy is to deliver a large dose of radiation to the tumor with a minimum dose to the healthy tissue. When the tumor is situated below the skin surface it is necessary to use radiation which gives a high-percentage depth dose. This percentage depth dose is defined as the ratio of the dose received at a depth below the surface to the maximum dose which occurs at or near the surface. Two important factors affect this percentage depth dose: (*a*) the distance from the source of radiation to the skin (SSD), and (*b*) the energy of the radiation. If the SSD is 10 cm, then the dose received at a point 10 cm below the surface of the skin cannot be greater than 25% in accordance with the inverse square law for a diverging beam. In practice, the percentage depth dose is even less than this, because of the absorption of the radiation. As the energy of the radiation is increased, the beam becomes more penetrating, and more radiation is delivered to the underlying layers of tissue.

When radiations of energy greater than 1 mev interact with matter, most of the electrons are projected in the forward direction, so that the energy absorbed in the superficial layers of the skin is less than that absorbed a few millimeters below the surface. For the radiation from Co^{60}, the maximum dose is delivered 5–6 mm below the surface. This is another advantage of high-energy radiation.

For many years large sources of radium (5–10 g) have found limited usefulness in the treatment of certain types of cancer. The dosage rate from these units is small, being about 10–12 r/min at a point 10 cm from the source. These units cannot be used at greater distances because of the low dosage rate, and so the percentage depth dose achieved is very small, being about equivalent to what can be obtained from a low-voltage x-ray machine. Nevertheless, because of the nature of the radiations, radium units have been used successfully in treating cancers where cartilage is involved. For these radiations, 1 g of fat will absorb about the same amount of energy as 1 g of bone, in contrast with the case of low-energy radiation where bone may absorb up to 10 times as much energy as the fat.

If a source of radium is made much larger than 10 g it becomes so thick that much of the radiation is lost by self-absorption within it. Aside from cost, this places an upper limit on the effective strength of such a unit. If the source is increased in area it is difficult to obtain a suitable beam of radiation.

In the Canadian reactor with its high neutron flux density, it is possible to produce sources of Co^{60} with specific activities of 20–60 curies/g in a reasonable length of time. One g of Co^{60} with an activity of 20 curies will give the same radiation output as 32 g of radium. It is therefore obvious that physically small sources with high activity are feasible using radioactive cobalt. With this higher activity, they may be used at larger SSD. The radiations from cobalt consist of 2 γ-ray lines of 1.17 mev and 1.33 mev, emitted in equal numbers as Co^{60} decays to Ni^{60}. The average energy of these is comparable to the energy of the radiations from radium sources.

In the summer of 1951 two sources of Co^{60}, each with an effective strength of 1000 curies, and having a specific activity of about 20 curies/g, were made available from the Canadian heavy water pile at Chalk River, for teletherapy units. One of these sources was installed in the University Hospital in Saskatoon, and the other in the Ontario Cancer

[1] Physicist to the Saskatchewan Cancer Commission.

Foundation, Victoria General Hospital, London. The sources are 1 in. in diameter and about 0.5 in. thick and were assembled from a number of thin disks. Both sources give an output of 33 r/min at a point 80 cm from the source. Details of the problem of activating and handling the cobalt will be found elsewhere (*1*).

Before the design of the teletherapy units was undertaken, discussions were held with many radiologists as to the essential requirements of such units in output, field sizes, treatment distances, and sharpness of collimation. Preliminary investigations were made, theoretically and with trial sources, to see how these requirements could best be met, and preliminary results with one trial source have been published (*2*). In these investigations there was close collaboration among Eldorado Mining and Refining (1944) Ltd., the University of Saskatchewan, and the National Research Council. With the same ultimate objectives, two units, quite different in mechanical construction, were designed and have now been tested.

The unit installed at the University Hospital in Saskatoon was designed by two of the authors (H. E. J. and L. M. B.), with the assistance and advice of T. A. Watson, director of Cancer Services, Saskatchewan Cancer Commission. This unit consists of a head, capable of rotation about a horizontal axis, between two arms of an inverted, U-shaped yoke. The yoke is attached to an overhead carriage by means of telescoping steel tubes. The carriage may be moved along horizontal rails mounted near the ceiling. The weight of the head is carried by steel cables which pass over a pulley system to counterweights behind a wall at one end of the room. The head is made of lead encased in a steel cylinder about 20 in. in diameter and 22 in. in length and weighs about 1 ton. It can be rotated through 120° in a vertical plane so that the direction of the beam varies from vertically downward to somewhat above the horizontal. The vertical movement of the head is about 50 in. and the horizontal travel is about 80 in. The unit may be turned "off" or "on" by the rotation of a steel wheel mounted centrally in the head. This wheel, made of lead and tungsten alloy encased in steel, carries the cobalt source at one end of a diameter. In the "on" position, the source is exposed through a tapered opening in the lead shield. Rotation of the wheel through 180° to the "off" position surrounds the source with 10 in. of lead or its equivalent of tungsten alloy. The wheel is rotated by means of an electric motor requiring about 5 sec to turn the unit "off" or "on." As a safety feature the wheel may also be rotated manually. Measurements outside the head, with the beam off, indicate that the stray radiation 1 ft from the head is everywhere less than 7 mr/hr.

Collimation of the beam and limitation of the field size are achieved by interchangeable lead diaphragms with various circular or square openings. These are mounted on the end of a telescoping cylindrical sleeve fastened to the head. The SSD can be varied from 80 to 50 cm. The unit will be used most of the time at an SSD of 80 cm. Each diaphragm is attached to a light, stainless steel cone, 15–20 cm in length. These serve to fix the treatment distances and to indicate the field sizes.

TABLE 1

COMPARISON OF DEPTH DOSE GIVEN BY Co^{60} WITH THAT GIVEN BY A 2.0-MEV X-RAY MACHINE (*3*)
(FILTER 9 MM Pb)

Depth (cm)	Field size SSD	5 cm × 5 cm 100 cm	Field size SSD	10 cm × 10 cm 100 cm
	Cobalt	2-mev	Cobalt	2-mev
0.5	100	100	100	100
1.0	97	91	98	98
5.0	76	66	80	75
10.0	52	44	58	52
15.0	36	30	41	36
20.0	24	20	29	25

The other unit was designed by R. F. Errington and D. T. Green, of the Development Division of Eldorado Mining and Refining (1944) Ltd., and consists of a vertical pillar and base supporting a horizontal arm and yoke. The head is mounted in the yoke, on a horizontal axis, and can be rotated by a motor from about 5° above the horizontal downward to about 10° beyond the vertical. The horizontal arm can be moved vertically by a motor-driven screw, from about 27 in. above the base to about 84 in. above it.

The source is mounted near the horizontal axis of rotation, and the beam emerges through a conical opening. When the beam is shut off, this opening is completely filled with mercury. The switch that turns the beam on starts an air compressor mounted in the horizontal arm, and the air pressure forces the mercury into a reservoir outside the lead shielding, but enclosed in, the cover of the head. Turning the beam off releases a valve and allows the mercury to return under gravity, for all angulations of the head, into the conical opening. Failure of power automatically opens the same valve and shuts off the beam. The beam may be turned fully on or off in 5 sec. The stray radiation, with the beam turned off, is less than 6.25 mr/hr everywhere on the surface of the head.

The collimating system, attached to the head in front of the beam orifice, consists of 4 rectangular lead blocks, each with one end constrained to maintain contact with a side of the adjacent one while moving in a plane at right angles to the axis of the beam. The blocks can be separated, or brought together, by lever systems so that square or rectangular fields, with dimensions between 4 cm × 4 cm and 20 cm × 20 cm at 100-cm SSD, can be obtained. The shutter system can be retracted along the beam axis for treatment at any distance between 100 and 70 cm. With a 70-cm treatment distance, the end of the shutter system is about 13 cm from the patient. This separation is necessary to reduce the intensity of the electrons scattered from the collimating blocks.

Field localization is obtained by means of a light beam originating at the same distance from the pa-

tient as the radiation, and defined by the diaphragm system just as the γ-ray beam is.

Measurements were carried out by the group in Ottawa and by the group in Saskatoon. Depth dose measurements were made and isodose distributions determined for a variety of field sizes and source-to-skin distances. The results obtained by the two groups are in excellent agreement. A description of the methods and the details of the results will be published elsewhere (*1*). A summary of the results is given in Table 1 in which cobalt radiation is compared with that obtainable from a 2-mev Van de Graaff generator (*3*). In the first two columns, results are for a 5 cm × 5 cm field at an SSD of 100 cm, and in the last two columns results are given for a 10 cm × 10 cm field. In both cases the percentage depth dose obtainable with the cobalt is considerably greater than that reported for the 2-mev x-ray machine. In fact, the distributions of radiation are more nearly comparable with 3-mev x-rays (*4*).

The units should require less service and be more flexible in use than x-ray machines. The cobalt offers an alternative to x-ray machines in the 2–4-mev range.

References

1. *Brit. J. Radiology* (in press).
2. Dixon, W. R., Fish, F. H., and Morrison, A. *J. Can. Assoc. Radiologists*, **2**, 12 (1951).
3. Trump, J. G., *et al. Am. J. Roentgenol. Radium Therapy*, **57**, 703 (1947).
4. Trump, J. G., and Cloud, R. W. *Ibid.*, **49**, 531 (1943).

Manuscript received October 29, 1951.

Absorption of DDT in Houseflies over an Extended Period[1]

Robert A. Hoffman, A. R. Roth, Arthur W. Lindquist, and Joseph S. Butts

Bureau of Entomology and Plant Quarantine, ARA, U. S. Department of Agriculture, and Oregon State College, Corvallis

Studies on absorption of DDT by houseflies (*Musca domestica* L.) are usually based on an analysis of the extract of the flies 24 or 48 hr after treatment of the insect. Sternburg and Kearns (*1*), Perry and Hoskins (*2*), and Lindquist *et al.* (*3*) have reported on results obtained on this basis. Recent work in this laboratory has shown that the timing of the analyses in experiments of this type is very important. Considerable differences in the external and internal distribution of DDT may result if attention is not paid to this point.

In studies on absorption the writers radioassayed Orlando resistant flies that had been treated individually with acetone solutions of radioactive DDT about one year previously. Each fly had received 15 μg of DDT on the thorax, and the flies had been stored in pillboxes in the laboratory. They were prepared for radioassay by relaxing them in a high-humidity chamber and rinsing them in 5 ml of acetone for 30 sec to remove the DDT on the exterior of the body. The flies or dissected parts were then macerated in the presence of acetone. When the material was dry, the radioactivity was determined in a windowless gas-flow counter attached to a scaler. Measured amounts of the insecticide solution applied to counting plates with a microsyringe showed that 1 μg of DDT produced 165–180 cpm with this equipment. These figures were used in computing the micrograms of DDT or metabolites found in the extracts of the fly tissues.

[1] Published as Technical Paper No. 690 with the approval of the director of the Oregon Agricultural Experiment Station and the chief of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

TABLE 1

Distribution of DDT or DDT Metabolites in Flies 385 Days after Death. One μg Radioactive DDT was Equivalent to 165 cpm

Dissected parts	DDT or metabolite absorbed per fly	
	μg	Percentage of total
Internal organs, muscle, body fluids, gut, etc.	3.50	53
Cuticle-hypoderm:		
Top of thorax	0.56	9
Abdominal	.68	10
Remainder of thorax, legs, and wings	1.15	18
Entire head	0.64	10
Total	6.53	100

Radioactivity measurements indicated that an average of 5.8 μg DDT/fly had penetrated the integument of the flies surviving the DDT application, and that 3.3 μg remained on the exterior. Similarly, flies succumbing to the applied DDT showed a penetration of 7.5 μg each and a surface retention of 3.3 μg. This is in marked contrast to the 2.0 or 2.6 μg absorbed when the radioassay was performed 24–48 hr after the flies were treated (*3*).

In order to determine the morphological distribution of the DDT or metabolites, 10 of the flies were dissected. Table 1 shows that 3.50 μg of DDT or metabolites were in the internal organs. Previously, Lindquist, Roth, Hoffman, and Butts (*4*) made dissections of flies 24–48 hr after treatment and found an average of 0.271 μg, or 26–34% of the amount absorbed, in the internal organs; the remainder was in the cuticle-

TABLE 2

Absorption of DDT or DDT Metabolites in Flies at Intervals after Treatment (5.9 μg Radioactive DDT Applied per Fly). One μg was Equivalent to 180 cpm

Days after treatment	Surviving flies		Dead flies	
	External wash (μg)	Extract of fly (μg)	External wash (μg)	Extract of fly (μg)
1	3.8	0.39	4.5	0.41
5	2.9	.71	3.9	.74
7	2.2	.88		
9	1.5	1.26	2.9	1.09

TABLE 3

AMOUNTS OF DDT OR DDT METABOLITES PRESENT IN VARIOUS PARTS OF FLIES SURVIVING AN 11.25 μG DOSAGE OF RADIOACTIVE DDT (6 TO 10 FLIES EXAMINED ON EACH DATE). ONE μG WAS EQUIVALENT TO 180 CPM

Dissected parts	After 2 days		After 6 days		After 10 days	
	μg	Percentage of total	μg	Percentage of total	μg	Percentage of total
Body fluids	—	—	0.23	9.7	0.30	9.6
Reproductive system	0.24	20.2	.33	13.8	.50	17.4
Intestinal tract	.03	2.8	.12	5.0	.10	3.3
Thoracic ganglion	.05	4.3	.12	5.2	.07	2.4
Thoracic muscle	.04	3.8	.14	6.1	.16	5.2
Abdominal and thoracic cuticle-hypoderm	.44	37.0	.70	29.6	1.03	34.3
Wings, legs, head	.38	31.9	.72	30.6	.84	27.8
Total	1.19	100.0	2.36	100.0	3.00	100.0

hypoderm. Sternburg and Kearns (*1*) found by chemical analysis that very little, if any, DDT or DDE (1,1,dichloro-2,2-bis(*p*-chlorophenyl) ethylene) was present in the interior parts of resistant houseflies treated with DDT. The penetration and distribution of DDT in flies over a long period of time appear to be physical phenomena. Richards and Cutkomps (*5*) showed that cuticle and purified chitin absorbed part or all of the DDT when placed in moderately dilute suspensions of DDT in distilled water.

In order to obtain information on the rate of absorption over a period of several days, Orlando resistant flies were treated on the thorax with 5.9 μg radioactive DDT/fly and held at room temperature (60°–75° F). In 24 hr the mortality was 25%. From 6 to 10 survivors were killed at intervals, and a radioassay was made of the amount of DDT absorbed. Table 2 shows that the amount absorbed increased from 0.39 μg after 1 day to 1.26 μg after 9 days. The flies that died within 24 hr showed a similar trend.

The increase in amount of DDT absorbed suggested further tests to determine whether the absorbed radioactive DDT was concentrated in certain organs. Flies were treated with 11.25 μg DDT each, and the mortality was 54% in 24 hr. As shown in Table 3, the total internal radioactivity of these flies increased with time, up to 10 days, but the morphological distribution did not change. From 31 to 40% of the total DDT applied was found in the internal systems, and the remainder was in the cuticle. The amount absorbed per fly was considerably greater than that resulting from treatments with 5.9 μg (Table 2). This is in agreement with the results of Sternburg *et al.* (*1*), who had shown that absorption of DDT was greater with larger applications.

These experiments demonstrate the importance of timing the analysis of flies in DDT-absorption studies. A 5-day delay in the analysis of flies succumbing within 24 hr after treatment increased the amount of DDT absorbed as much as 45%, and 9-day delay 62%. About the same increase was obtained for flies that survived the DDT treatment for 5 days, indicating that absorption of DDT proceeds at about the same rate in dead as in living flies. Treated flies radioassayed after a lapse of more than a year showed a large increase in the amount of DDT penetrating the integument.

References

1. STERNBURG, J., and KEARNS, C. W. *Ann. Entomol. Soc. Am.*, **43**, (3), 444 (1950).
2. PERRY, A. S., and HOSKINS, W. M. *Science*, **111**, 600 (1950).
3. LINDQUIST, A. W., *et al. J. Econ. Entomol.*, **44**, 167 (1951).
4. *Ibid.* (In press).
5. RICHARDS, A. G., and CUTKOMPS, L. K. *Biol. Bull.*, **90**, 97 (1946).

Manuscript received October 22, 1951.

The Accumulation of Serum Cholate and its Relationship to Hypercholesteremia[1]

Meyer Friedman, Sanford O. Byers, and Ray H. Rosenman[2]

Mount Zion Hospital, Harold Brunn Institute for Cardiovascular Research, San Francisco, California

Hypercholesteremia can be produced in the rat by such different procedures as (1) ligation of the bile duct (*1, 2*); (2) production of experimental nephrosis (*3*); and (3) injection of Triton W 1339 (*6*). Recently we have obtained evidence (*4–6*) which indicates that each of these procedures also induces a rise in the cholate content of the animal's blood. It is the accumulation, moreover, of this latter steroid that appears responsible for the ensuing hypercholesteremia observed in the above conditions. In other words, the rise in cholesterol content of plasma seems to be a phenomenon *secondary* to the "hypercholatemia" effected by these particular procedures. The mechanism, however, by which excess accumulation of cholate in blood induces hypercholesteremia is still to be determined.

In view of the above findings concerning the primacy of cholate accumulation in the pathogenesis of

[1] Aided by grants from the American Heart Association and the United States Public Health Service.

[2] With the technical assistance of Barbara Gunning.

TABLE 1

THE SERUM CHOLATE IN NORMOCHOLESTEREMIC AND HYPERCHOLESTEREMIC SUBJECTS

Type of subject	No.	Av age	Total serum cholesterol (Mg/100 ml)			Total serum cholate (Mg/100 ml)			Cholesterol/ cholate ratio
			Mean	S. E. mean	Range	Mean	S. E. mean	Range	
Normal	25	29	228	± 8.7	(110–280)	5.3	± .26	(1.7–7.2)	43
Patients with nephrosis	12	6	660	±56.0	(390–1000)	19.9	±3.0	(9.8–44.0)	33
Patients with xanthoma	6	47	456	—	(330–600)	15.4	—	(9.0–32.0)	30
Patients with diabetes	5	54	445	—	(410–490)	15.0	—	(12.0–17.0)	30
Patients with myocardial infarct	8	50	388	±14.7	(320–465)	12.8	±1.4	(10.5–16.0)	30
Patients with hypothyroidism	2	46	352	—	(310–395)	12.0	—	(12.0–12.0)	29

various experimental forms of hypercholesteremia, it appeared important to investigate whether hypercholatemia is present in clinical states of hypercholesteremia. The results of such a study are reported in this communication.

Blood samples[3] obtained from normal subjects and patients suffering from disorders frequently associated with hypercholesteremia were analyzed for their serum cholesterol content according to methods previously described (*2*). Sera containing less than 300 mg of cholesterol/100 ml were considered normocholesteremic, and those containing more, hypercholesteremic. A number of the normocholesteremic samples obtained from normal subjects and also a group of samples selected from known hypercholesteremic patients were analyzed for their cholate content by absorption photometry according to a combination of the methods of Minibeck (*7*) and Wilken (*8*). The chemical analysis for cholate was not found to be influenced by variations in the cholesterol or lipid content of the sample.

As Table 1 indicates, the average serum cholate of 25 young normal subjects (having an average serum cholesterol of 228 mg/100 ml) was 5.3 mg/100 ml (range: 1.7–7.2; S. E. mean: ± 0.26).

Hypercholesteremia, on the other hand (Table 1) was invariably associated with an elevation of serum cholate (hypercholatemia). Moreover, the amount of cholate accumulation appeared to be more closely correlated with the degree of hypercholesteremia than with any particular disease entity. Thus, the 12 patients with nephrosis whose average serum cholesterol was 660 mg/100 ml had an average cholate of 19.9 mg/100 ml (range: 9.8–44.0; S. E. mean: ± 3.0). The 8 patients with myocardial infarction, on the other hand, had a much lower serum cholesterol (388 mg/100 ml) and a corresponding lower cholate (12.8 mg/100 ml). In both groups, however, the cholesterol/cholate ratio remained about the same. The same relationships between cholesterol and cholate also were observed in the patients with xanthoma, diabetes, and hypothyroidism (Fig. 1).

The present study indicates that an elevated blood cholate level occurs in practically all cases of hypercholesteremia, irrespective of the latter's seeming etiology. The degree of hypercholesteremia moreover appears to bear a close relationship to the extent of hypercholatemia.

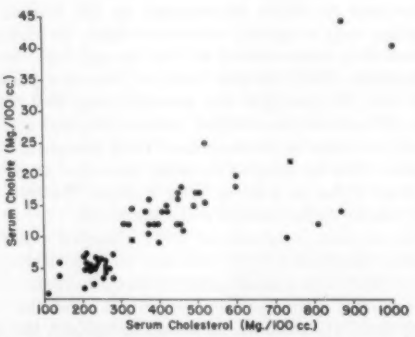


FIG. 1. The relationship of serum cholate to serum cholesterol in the normocholesteremic and hypercholesteremic subject.

These findings appear important because experimental accumulation of cholate itself in plasma has been found by us (*5*) to produce hypercholesteremia. Moreover, such diverse states as biliary obstruction and experimental nephrosis lead to hypercholatemia, which in turn evokes hypercholesteremia.

These findings suggest that clinical hypercholesteremia may be a phenomenon secondary to an initial derangement of cholate metabolism. Such a relationship cannot be considered too surprising when it is recalled that considerable data have been amassed (*9–11*) that suggest some sort of metabolic relationship between bile salts and cholesterol.

The present findings also indicate that the role of the liver (either as a primary or a secondary agent)

[3] The authors wish to express their thanks to John Gofman for his kindness in supplying a number of the blood samples analyzed in this study.

must be kept in mind in any evaluation of the factors involved in the pathogenesis of human hypercholesteremia.

References

1. Chanutin, A., and Ludewig, S. J. *Biol. Chem.*, **115**, 1 (1936).
2. Byers, S. O., Friedman, M., and Michaelis, F. *Ibid.*, **184**, 71 (1950).
3. Heymann, W., and Hachel, D. B. *Federation Proc.*, **10**, 358 (1951).
4. Friedman, M., and Byers, S. O. *Federation Proc.* (in press).
5. ———. *Proc. Soc. Exptl. Biol. Med.*, **78**, 528 (1951).
6. Friedman, M., and Byers, S. O. *Am. J. Physiol.* (in press).
7. Minibeck, H. *Biochem. Z.*, **297**, 29, 40, 214 (1938).
8. Wilken, W. *Klin. Wo-chschr.*, **16**, (2), 1350 (1937).
9. Bloch, K., Berg, B. N., and Rittenberg, D. *J. Biol. Chem.*, **149**, 511 (1943).
10. Sperry, W. M., and Stoyanoff, V. A. *Ibid.*, **121**, 101 (1937).
11. Wright, A., and Whipple, G. H. *J. Exptl. Med.*, **59**, 411 (1934).

Manuscript received November 19, 1951.

Growth of the Scutellum of Maize in Culture

Carl D. LaRue

Department of Botany,
University of Michigan, Ann Arbor

The discovery (*1*) that maize embryos of small size upon excision gave rise to small plants, and that those of larger size at time of excision gave larger ultimate sizes of embryos, and Merry's (*2*) evidence of the same situation in barley embryos suggest that if embryos could be held in an embryonic condition until they had grown beyond the normal size of embryos in mature seeds, and then planted, they should give rise to seedlings and mature plants of abnormally large size. Kent and Brink (*3*) had considerable success in preventing germination of barley embryos and in continuing their embryonic growth by the use of tomato juice in culture.

In trials with maize, tomato juice had little or no effect on embryos, although it did serve to expedite the growth of corn endosperm in culture (*4*). Any check in germination of the embryos was so slight as to be of no importance in producing embryos of abnormal size.

Since the root and the shoot could not be kept from growing out, thus producing germination and setting up seedling growth, rather than the desired embryonic growth, it seemed that the scutellum at least might be led to continue embryonic growth by the removal of the root-stem axis. Following this idea, numbers of embryos of the variety Evergreen, which were nearing mature size, were excised and the root-stem axis was removed from each. At the same time embryos of Golden Bantam variety were treated in the same way, but these were in an earlier stage of growth than the Evergreen. One set of each variety was grown on White's medium and one on White's medium plus tomato juice, as used by Kent and Brink.

A set of Evergreen embryos was weighed and measured to serve as controls, then dried and weighed to give the dry weight. Golden Bantam embryos were treated in the same way. It is obvious from Table 1 that the Golden Bantam embryos were a great deal younger than those of the Evergreen. The cultures were continued until growth ceased. Wet and dry weights and measurements of length and width of the scutelli were obtained.

TABLE 1

Weights of Cultured, Control, and Ripe Scutelli of Maize

Variety	Treatment	Av wt (mg)	
		Wet	Dry
Evergreen	Cultured	977.3	224.2
"	Control	171.0	126.8
"	Ripe	393.9	154.3
Golden Bantam	Cultured	90.0	27.3
" "	Control	18.9	13.3
" "	Ripe	252.6	150.0

TABLE 2

Lengths and Widths of Cultured, Control, and Ripe Scutelli of Maize

Variety	Treatment	Av length (mm)	Av width (mm)
Evergreen	Cultured	12	9.0
"	Control	5	4.5
"	Ripe	6.5	6.0
Golden Bantam	Cultured	5.5	3.0
" "	Control	3.0	2.0
" "	Ripe	6.0	5.0

For comparison with the cultures and controls, ripe grains of the two varieties were soaked and germinated. When the embryos were fully expanded the root-stem axes were removed from them, and wet and dry weights and length and width measurements were taken.

In the cultures a number of scutelli formed outgrowths that were partial roots or partial stems. These growths were apparently due to incomplete excision of the root-stem axis rather than to regeneration. All such scutelli were removed from the experiment. No true regeneration of scutelli was seen, but some scutelli did develop papillate or even calluslike outgrowths on their surfaces. More outgrowths were seen on the medium with tomato juice than on the plain White's medium, but the differences were not great and both sets were thrown together in the tables.

The scutelli of Golden Bantam corn grew fairly well and showed nearly a fivefold increase in net weight and more than a doubling of the dry weight. They never, however, approached the size or weight of the scutelli from ripe seeds—a result, probably, of excision at a stage definitely too young.

The Evergreen scutelli made a much better showing and at the end were nearly twice as large and as heavy as those from normally ripened seeds.

Tables 1 and 2 show that one can take scutelli from

embryos near mature size and, by removing the meristems, thus making them incapable of germination, carry the scutelli on in growth of an embryonic type until maximum size. Since these cultured entities lack any organized meristems, they do not give positive evidence that if whole embryos could be held back in development and induced to continue embryonic growth they would eventually be able to produce mature plants of abnormally large size, but they do at least suggest this possibility.

References

1. LaRue, C. D. *Bull. Torrey Botan. Club*, **63**, 365 (1936).
2. Merry, J. *Ibid.*, **69**, 360 (1942).
3. Kent, N., and Brink, R. A. *Science*, **106**, 547 (1947).
4. LaRue, C. D. *Am. J. Botany*, **36**, 798 (1949).

Manuscript received November 7, 1951.

Perchloric Acid Extraction of Ribose Nucleic Acid from Cytological Preparations

Henry S. Di Stefano

Department of Anatomy, State University of New York College of Medicine at Syracuse

Ogur and Rosen (*1, 2*) have reported a method for differential extraction of ribose and desoxyribose nucleic acids from tissues. They find that treatment of tissues with 10% perchloric acid at 4° C for about 18 hr will selectively extract ribose nucleic acid. Desoxyribose nucleic acid may then be removed by treating with 5% perchloric acid at 70° C for 20 min. Cytochemical adaptations of this technique have also been reported by Erickson, Sax, and Ogur (*3*) in plant material and by Sesehachar and Flick (*4*) in protozoan material. These authors found that cold perchloric acid treatment does in effect remove the basophilia due to ribose nucleic acid from the cytoplasm and from nucleoli. Koenig (*5*), however, found that a somewhat higher temperature is necessary to remove basophilia from cytoplasm and nucleoli of formalin-fixed mammalian tissues, which was also found to be true by the author (unpublished) for Carnoy-fixed mammalian material. Sulkin and Kuntz (*6*), working with Zenker-fixed mammalian tissues, reported that cold perchloric acid treatment has no effect on deparaffinized sections. They did find that when the cold perchloric acid is allowed to act on the fixed tissue before it is embedded, or if it is allowed to act on frozen sections of the fixed material, this method can be used as a substitute for ribonuclease digestion in the removal of ribose nucleic acid from cytological preparations. In this laboratory perchloric acid extraction of ribose nucleic acid from cytological preparations and its effect on desoxyribose nucleic acid during this time were studied photometrically. Results of ultraviolet absorption studies and of absorption studies of Feulgen-stained sections are herein presented.

For these studies, rat pancreas was fixed in Carnoy's acetic alcohol (1:3), sectioned at 3 μ, and all slides were prepared from the same ribbon.

The method of photometric analysis employed throughout the experiment has been described in detail by several authors (*7–11*). The apparatus used is essentially the same as the one described by Pollister and Moses (*12*).

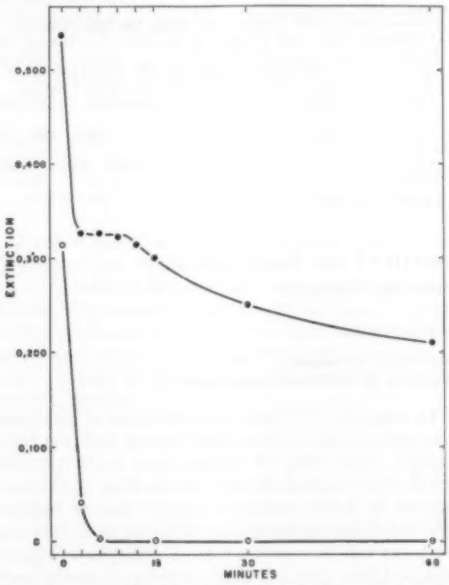


Fig. 1. Curves showing the relationship between ultraviolet extinction and duration of perchloric acid treatment: ●—●, curve for nuclei; ○—○, curve for cytoplasmic cores. Each point represents a mean extinction value of 15–25 measurements.

The natural ultraviolet absorption of nuclei having a diameter of about 6 μ, and of cores of cytoplasm 4 μ in diameter, was measured in sections treated for varying periods of time with 10% perchloric acid at 25° C. In order to study the effect of the perchloric acid treatment on the desoxyribose nucleic acid, after the perchloric acid treatment, the sections were stained by means of the Feulgen reaction. Sections were hydrolyzed for 12 min at 60° C in 1 *N* hydrochloric acid (*8, 9*), stained for 1 hr in Schiff reagent, prepared according to the directions published by Stowell (*13*), and measurements were then made of the intensity of the Feulgen dye bound by the nuclei. In addition, photometric measurements were also made of Feulgen control slides which were placed in Schiff reagent together with the test slides. Except for hydrochloric acid hydrolysis, these were treated in the same manner as were the test slides.

A Photovolt photometer (Model 512) with an electron multiplier tube was used for measuring the ultraviolet absorption of nuclei and cytoplasmic cores. The light source for these measurements was the 2537 A

line, isolated from a Hanovia mercury lamp (Sc 2537 U-shaped lamp with polished quartz end window) by means of a Cooke double prism quartz monochromator. For measurements of absorption resulting from the combined Feulgen dye, the Photovolt photometer with the standard B search unit was employed. For these measurements a Farrand interference filter with a maximum transmission peak at 560 mμ was used to isolate the desired light from a Western Union J100 lamp.

Since the nuclei are about 6 μ in diameter, sections 3 μ thick were used in making absorption measurements, so that in the ultraviolet there would be no cytoplasmic material above and below the nucleus to obscure the absorption picture.

Results of photometric measurements of ultraviolet absorption after various periods of perchloric acid treatment are represented in Fig. 1. Each point has been corrected for nonspecific absorption (*7*), which was measured by means of a blank. The latter was prepared by treating the section with a 5% solution of trichloracetic acid for 15 min at 90° C, which, according to Schneider (*14*), removes all nucleic acids. For nuclei this was found to be an extinction value of 0.149 ± 0.004, and 0.221 ± 0.005 was the value measured for cytoplasmic cores. Fig. 1 shows that very early in the treatment there is a sharp decline in both nuclear and cytoplasmic ultraviolet absorption, which is due to the extraction of nucleic acid or of nucleic acid fragments. In the cytoplasm this decline approaches zero after about 6 min of treatment. In the nucleus the drop in extinction appears to level off somewhat sooner; it remains at this level for a short period of time and resumes its decline after 9 min.

In Fig. 2 are represented the results obtained when the Feulgen reaction was employed to study the effect of perchloric acid treatment on desoxyribose nucleic acid. There is no change in the intensity of the reaction during the early part of the treatment, at a time when the ultraviolet extinction of both the nucleus and the cytoplasm was shown to be greatly reduced. Beyond 9 min, however, the amount of Feulgen dye bound by the nuclei begins to diminish. No differences were found between the extinction value of nuclei of control sections which received no perchloric acid treatment, and nuclei of sections which were treated for 9 min. Since this color was found to transmit more than 97% of the light, no correction was deemed necessary for extinction values of Feulgen dye of test sections. Following treatment for more than 9 min, however, there is a gradual increase in the intensity of color produced in control sections.

Since it is generally accepted that desoxyribose nucleic acid is not found as a normal cytoplasmic component, one might assume that the observed decrease of cytoplasmic ultraviolet extinction is the result of extraction of ribose nucleic acid by the perchloric acid. The decrease in ultraviolet extinction of nuclei during this period of time, coupled with the fact that there is no change in the amount of Feulgen dye bound by these nuclei, appears to constitute evidence that, in the nucleus as well as in the cytoplasm, perchloric acid is extracting ribose nucleic acid without removing desoxyribose nucleic acid to any appreciable extent. Beyond the 9-min period of perchloric acid treatment, however, the ultraviolet absorption, after having leveled off, resumes its decline at a somewhat slower rate than that of the initial fall. This corresponds to the time when the curve of the Feulgen controls begins to show more and more color with increased time of treatment, which would suggest that these events may be explained on the basis of a hydrolysis of the desoxyribose nucleic acid similar to that of mild hydrochloric acid hydrolysis, which is used in the standard Feulgen procedure.

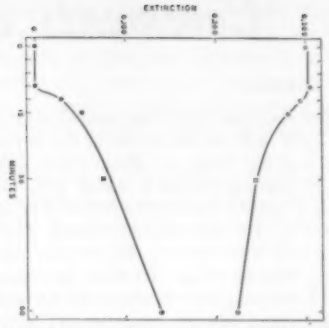


FIG. 2. Absorption measurements showing the relationship between duration of perchloric acid treatment and the amount of Feulgen dye bound by nuclei: ○—○, Feulgen sections: ●—●, control sections. Each point is a mean extinction value of 15–25 nuclei.

References

1. OGUR, M., and ROSEN, G. *Federation Proc.*, **8**, 234 (1949).
2. ———. *Arch Biochem.*, **25**, 262 (1950).
3. ERICKSON, R. O., SAX, K. B., and OGUR, M. *Science*, **110**, 472 (1949).
4. SESCHACHAR, B. R., and FLICK, F. W. *Ibid.*, 659.
5. KOENIG, H. *J. Natl. Cancer Inst.*, **10**, 1346 (1950).
6. SULKIN, N. M., and KUNTZ, A. *Proc. Soc. Exptl. Biol. Med.*, **73**, 413 (1950).
7. POLLISTER, A. W., and RIS, H. *Cold Spring Harbor Symposia Quant. Biol.*, **12**, 147 (1947).
8. DI STEFANO, H. S. *Chromosoma*, **3**, 282 (1948).
9. RIS, H., and MIESKY, A. E. *J. Gen. Physiol.*, **33**, 125 (1949).
10. LEUCHTENBERGER, C. *Chromosoma*, **3**, 449 (1950).
11. SWIFT, H. H. *Physiol. Zool.*, **23**, 169 (1950).
12. POLLISTER, A. W., and MOSES, M. J. *J. Gen. Physiol.*, **32**, 567 (1949).
13. STOWELL, R. E. *Stain Technol.*, **20**, 45 (1945).
14. SCHNEIDER, W. *J. Biol. Chem.*, **181**, 293 (1945).

Manuscript received October 23, 1951.

Comments and Communications

Soviet Science

READERS concerned with the present state of science in the USSR will be interested in the review of my *Genetics and the Races of Man*, which appeared in the Soviet journal *Nauka I Zhizn* (7), (1951). In particular it will be instructive to compare this notice with that by Th. Dobzhansky, which appeared in SCIENCE, **113**, 264 (1951). My thanks are due to Alfred G. Meyer, of the Russian Research Center, Harvard University, for checking the accuracy of my translation.

From "Science à la Américaine," by B. E. Bykhovskiĭ, Doctor of Philosophical Sciences:

> The reactionary geneticists show themselves as frank tools of American racism. Boston University Professor William Boyd recently released a book with the significant title "Genetics and the Races of Man." This "work" of an American geneticist was forthwith advertised as "a revolution in anthropological thinking founded on Morganism." This "revolution" consists in the fact that Boyd put "a new theoretical foundation" under race hatred. Not being able to deny the obvious bankruptcy and pseudoscientific character of the racist theories preached by the Hitlerite fascism, Boyd sets himself the goal of renovating and bolstering up racism with the aid of genetical metaphysics. "If racial categories are to have a sound theoretical foundation," declares Boyd, "they should be based on the genetical constitution of man." In order to realize this aim, Boyd proposes a "method" of defining and classifying human races on the basis of "genetical analysis" of the blood. "Blood groups," preaches this myrmidon of racism, "give the most reliable information for racial anthropology, since they are not influenced by the environment." Thus Morgan genetics inspires American racist "methods" for determining racial affinities and the percent of "Anglo-Saxon" blood. The genetical rearmament of racism by the Boston professor will doubtless be enthusiastically greeted by the Klu-Klux-Klanners and the bloody butchers of the heroic Korean people. The "genetical method" proposed by Boyd to determine six races, agreeing with the results of skin color—that is the priceless gift of the American Morganists to American fascism.

WILLIAM C. BOYD

School of Medicine
Boston University

BELIEVE it or not, the "Lament of a Moneyed Man" (SCIENCE, **113**, 333 [1951]) has found its way into the Soviet press, where it has been reproduced, in part, under the title "Science in the American Style," with a subtitle "Mister Babbitt Seeks Entry into the Pantheon of Science" (*Liter. Gaz.*, (141), 4 [1951]).

Bykhovskiĭ, who expatiates for the Soviet reader on this playful letter to SCIENCE, reports it as coming from an "enraged New York businessman" and says: "There are few scientific treatises which reveal the very essence of bourgeois *Weltanschauung* with such conclusiveness; there are few pamphlets which describe the 'American way of thinking' with such clarity as does this short letter from one of the representatives of the ruling class of the United States of America."

A moneyed man's whimsical suggestion that, because in one week he earns more money than Gibbs did in a year he should therefore have 52 busts in the Hall of Fame to match Gibbs' one, arouses supreme disgust: "That's how the present bosses of America assess the value of science. A statue of Mister Babbitt amid the ruins of American culture!"

Innocent whimsey has thus been put to the service of a propaganda without principle and made to contribute to the systematic defamation in the Soviet press of all things American.

IVAN D. LONDON

Russian Research Center
Harvard University

Lytic Effect of Tygon Plastic Tubing

NORMALLY, chicken red blood cells can be kept without hemolysis for a week or longer. During the course of immunogenetical studies of the red blood cellular antigens in the chicken, hemolysis of the cells of some of the blood samples occurred within 1–2 days after collection. The cause of this premature lysis was found to be associated with the Tygon Plastic Tubing (Formulation S22-1) used as part of the apparatus for the storage of the salt solution.

Several experiments were carried out in which the salt solution (2% sodium citrate, 0.42% sodium chloride) was held in Tygon tubing for periods of 8–26 days. All blood subsequently collected in glass tubes, each containing 1–3 ml of solution, turned dark within a few minutes, and hemolysis began in approximately half of the samples within 18 hr. Retention of the salt solution in Tygon tubing for a period of 24 hr was sufficient to cause some lysis. However, simply running the solution through the tubing did not produce this effect. It was also found that the concentration of the salt solution, up to 2.2% of sodium citrate and 0.5% of sodium chloride, was not responsible for the hemolysis.

When the "contaminated" solution was allowed to remain in contact with red blood cells for 30 min at room temperature and then separated from them by centrifugation, it lost its lytic properties: fresh blood cells added to such a solution were not lysed.

"Contamination" of the solution occurred when 1" strips of tubing were immersed in small amounts of the solution for 10 days prior to collection of the blood. However, if the pieces of Tygon tubing were thoroughly scrubbed with soap and water, no noticeable effect on the solution was obtained. Boiling long lengths of tubing (10 min) or washing the inside of the tubing with soap and water without scrubbing

failed to prevent subsequent "contamination" of the salt solution.

The cells of a bird collected at different times did not react uniformly to the same solution. Limited experiments also indicate that there may be individual differences among birds in susceptibility to lysis. The nature of the specific contaminant has not been determined.

FRED T. SHULTZ

Division of Poultry Husbandry
University of California, Berkeley

The Language of Science

I CANNOT help wondering whether the current disputants about the language problem in science have not rather lost their sense of historical perspective. This problem has only existed for about 300 years, which is a minute slice of history. Prior to that time the acquisition of four languages—Latin, Greek, Hebrew, and Arabic—placed the literature of the then known world at the disposal of the scholar. Probably 90 per cent of all scholars used only Latin.

If Latin were reintroduced as a universal language in science it would solve many of the problems raised by your correspondents: (1) There already exists a considerable volume of literature in Latin. One of the objections to the introduction of a synthetic tongue is the innumerable arguments that would immediately arise as to style. (2) The language is not spoken by any living group today, so that no national feelings would be hurt by its adoption.

The suggestion that Latin is inadequate to express the needs of science could only be made by one totally unacquainted with philology. Every language is continuously adapting itself to the needs of the civilization in which it is used, and Latin is just as flexible as any other tongue. I agree with Professor Faegri that every contemporary worker would continue to have to learn English, French, and German—in my field Spanish and Italian are almost as important—but I do not see why we should insist on passing on to our descendants the curse of Babel which fell on our ancestors. Five hundred years from now the scientific literature of part of the sixteenth and almost all of the seventeenth, eighteenth, and nineteenth centuries would be regarded by scientific historians as a specialized field to be avoided by those not linguistically inclined. Anything of truly permanent value would, of course, by that time have been translated into Latin.

PETER GRAY

Department of Biological Sciences
The University of Pittsburgh

THE discussion about language problems in science is of more than purely academic importance. My mother language is a "small" one, and I had of course to learn English, French, and German well enough to speak and write them. I certainly would not like to have to learn a fifth language, Esperanto (Lincicome, D. R. SCIENCE, 113, 607 [1951]), which, by the way, would not give me the great pleasure that English, French, and German gave me, of enjoying a firsthand knowledge of foreign literature. I therefore agree entirely with Knut Faegri's ideas (SCIENCE, 114, 399 [1951]).

I think, however, that something should be done. I know by personal experience how difficult it is to have every Italian graduate student master English and German well enough to get acquainted with genetic literature, and how American graduate students would rather not read German papers on the subject. In the past, science had an international language: Latin. Certainly I am not going to advocate the revival of this language.

What I think should be done is this: (1) let Unesco organize, through national committees and learned societies of each country, a poll to find out what modern language should be chosen as the "language of science;" (2) let the nations belonging to Unesco agree to have the teaching of this language compulsory at higher educational levels; (3) let every learned society in the world agree that every original contribution, experimental or otherwise, is going to be preferred for acceptance in its proceedings if written in the "language of science;" (4) let the editors of scientific journals do the same.

Such provisions would not be likely to produce immediate results; but after a decade or so every scientist would know that his discoveries would be bound to be ignored unless written in the accepted language; a young scientist would have to learn no foreign language if he is lucky enough to have the official language as his mother tongue, or just one if he lives in other countries. Knowledge of other languages would still be necessary for the old scientific literature, but the importance of this would decrease with time, and translations of the important papers into the "language" could be prepared.

This would not necessarily mean the death of every national scientific literature. Textbooks and general articles would still be written in the local language. Probably a smaller total output of scientific papers would be the end result, and this would certainly be welcomed. The original contributions, however, would become easily available to the whole world.

As to the language to be chosen, I for one am all in favor of English: It is already being used by the largest number of living scientists; it is well suited to the compactness of scientific language; there are already scientific journals being published in English by non-English speaking countries, such as Sweden. Last but not least, I know English already and I cannot be accused of linguistic nationalism by making such a proposition.

A. A. BUZZATI-TRAVERSO*

Università di Pavia, Italy

* Visiting professor, Department of Zoology, University of California, Berkeley.

Book Reviews

Chemistry of Wood. Erik Hägglund. New York: Academic Press, 1951. 631 pp. $13.50.

The author, a staff member of the Swedish Forest Products Research Laboratory, is well known for his research and writing in the field. This book is an English translation of a new and revised edition of *Holzchemie,* which first appeared in 1928 with a second German edition appearing in 1939.

The first two chapters outline the general physical properties and structure of wood and include a brief account of the growth, function, and morphology of the wood elements. The microphysical and chemical structure of the cell wall is discussed in a later section.

Chapter III, which constitutes about one third of the book, is concerned primarily with the chemical structure and reactions of cellulose and lignin and includes a short discussion of wood polyoses, polyuronic acids, and minor constituents such as resins, terpenes, tannins, phenolic heartwood extractives, and organic coloring matter.

The discussion of lignin is in greater detail than any of the other phases of wood chemistry, and in studying this section the reader might be left with a feeling of confusion. This is, however, not a reflection on the author but rather the result of an inherent confusion in the literature of this enigmatic material. The author has given a well-organized summary of present knowledge.

The remainder of the book is concerned with the chemical utilization of wood and includes discussions of wood saccharification, chemical pulping, pulp bleaching, pyrolysis, and alkaline degradation. Of these, pulping is given most attention, and the sulfite process, including the utilization of the spent sulfite cooking liquor, is discussed in detail. The soda process is only briefly mentioned, but the sulfate process is described at some length, particularly with respect to the role of sulfur in the delignification, and the nature of thiolignin.

The book concludes with a short section devoted to the natural decomposition of wood as related to fungal attack and the somewhat controversial interpretations, in the literature, of the biological and chemical changes that occur.

This monograph should not be considered a complete treatise on the complex subject of wood chemistry. Within the limits of a single volume, however, the author has done a commendable job of assembling and evaluating the literature. The discussions of several of the many subjects such as the swelling of wood and the significance and interpretation of analytical data are brief to the point of minimizing their importance. However, Hägglund has shown his awareness of this shortcoming through appended suggestions for further reading. In a few spots the writing takes somewhat the form of annotated bibliography, but for the most part the author has endeavored to interpret and consolidate the literature in the light of his own experience and research, and the book has gained in readability thereby. The subject matter is well indexed and profusely punctuated with references to the literature, particularly of recent European publications.

RALPH L. HOSSFELD

School of Forestry, University of Minnesota, St. Paul

Ruwenzori Expedition 1934–5: Muscidae, Vol. II, No. 6. F. I. van Emden. London: British Museum (Natural History), 1951. Pp. 325–710, 10 plates. £2 5s.

This is the concluding part of the classification of the Muscidae, the two preceding parts having appeared as contributions in Nos. 3 and 4 of the present volume published in 1939 and 1940. Keys to the species of all the genera revised for the first time are presented, but in the case of several genera, particularly *Phaonia* and *Dichaetomyia,* the keys are to be found in a preliminary report in Series 11, Vols. 9 and 10 of the *Annals* and *Magazine of Natural History,* published in 1942 and 1943.

With the publication of this series of papers Dr. van Emden has rendered a great service to students of the Muscidae of the Ethiopian region. His keys include all the described species he was able to place, and there are few omissions. As a result, it is now possible to bring together a complete review of the African fauna in only five publications instead of the scores that were previously required. A very important feature of the work was the examination of a goodly proportion of the types of previously described species, so that those that could not be recognized with certainty can now be properly placed. It naturally follows that some of the more recently described species fall into synonymy.

Of the 172 species and subspecies collected by the expedition and recorded in Part C, 94 are described as new. Add to these the 69 described in the preceding parts and we have a total of 163 new forms from a total of 302 species. An additional 48 new forms are described from other sources. The 106 text figures of distinctive characteristics are excellent and provide great assistance in identifying the species. The plates (with the exception of Plate X, on which the wings of 12 species are shown) show typical collecting localities for various species.

Dr. van Emden is to be highly congratulated for producing a volume that will prove of such great value to systematic and economic entomologists in Africa.

C. H. CURRAN

Department of Insects and Spiders
American Museum of Natural History

Dependably precise

Leitz® Microtomes

An increasing number of clinical and pathological laboratories rely on Leitz Microtomes for slicing tissue specimens with utmost accuracy and precision. Designed for easy, vibrationless operation, these outstanding instruments are surprisingly low in cost, ideally suited to a wide range of requirements. Compare . . . see the difference, in workmanship, convenience, dependability!

Leitz Base Sledge Microtome No. 1300

- Automatic feed, with cast-iron base plate
- Heavy sledge carries specimen holder and feed mechanism
- Thickness of section adjustable at will between 1 and 20 microns
- Object clamp inclines any direction, rotating about its own axis
- Freezing apparatus available

Leitz Freezing Microtome No. 1213

- Strong screw clamp for attachment to worktable
- Circular movement of knife around axis located between two pointed bearings
- Special track guides knife for utmost precision cutting
- Thickness of sections adjustable from 5 to 50 microns
- Knife cooling attachment, after Schultz-Brauns, available
- Automatic setting of the object

For details, Write Dept. SC

E. LEITZ, Inc., 304 Hudson St., New York 13, N. Y.

LEITZ MICROSCOPES • SCIENTIFIC INSTRUMENTS • BINOCULARS
LEICA CAMERAS AND ACCESSORIES

Publications Received

Proceedings and Papers of the Nineteenth Annual Conference of the California Mosquito Control Association. Conf. held at Riverside, Calif., March 11–14, 1951. Harold F. Gray, Ed. Berkeley: Calif. Mosquito Control Assoc., 1951. 99 pp.

Proceedings of the Symposia on Fuels, Fats & Oils and Research and Industry. Symposia held Aug. 12–18, 1950. S. Husain Zaheer *et al.*, Eds. Hyderabad-Deccan, India: Central Laboratories for Scientific & Industrial Research, 1951. 206 pp. Rs. 5–8–0.

Progress of Acetylene Chemistry in U. S. S. R. No. RJ–71. I. N. Nazarow. Trans. from the Russian. East Orange, N. J.: Assoc. Tech. Services, 1952. 7950 words, $31.80. (Originally appeared in *Uspekhi Khimii*, **20**, 309 [1951]).

Réarrangements Moléculaires et Inversion de Walden. International conference held at Montpellier, April 24–29, 1950. Paris: Centre National de la Récherche Scientifique, 1951. 152 pp. (No price given.) In French and English.

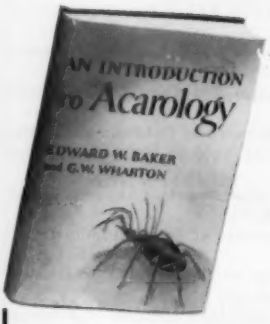
Revised Radial Velocities of Seventy-nine B-Type Stars. Pub. Dominion Astrophys. Observ., Victoria, B. C., Vol. VIII, No. 15. J. A. Pearce and R. M. Petrie. Pp. 409–427; ***An Estimate of the Relative Helium Content of the Early-Type Stars.*** Contrib. Dominion Astrophys. Observ., Victoria, B. C., No. 23. Anne B. Underhill. Pp. 447–457. (Repr. from *Can. J. Phys.*, **29**, 447 [1951]). ***The Dominion Astrophysical Observatory, Victoria, B. C.*** Ottawa: Dept. Mines and Technical Surveys (Dominion Observatories), 1951. 34 pp. Illus.

The Sciences in Navigation. A Symposium of Papers Presented in New York June 28–29, 1951. New York: Institute of Navigation, June 1951.

Studies on the Microbiological Retting Process for the Preparation of a Hard Fiber, and Influence of this Process on the Fiber Properties. Vol. XLVIII, No. 1. A. N. J. Heyn. Amsterdam, North-Holland Publishing Co., 1951. 59 pp. 8 plates.

Studies on New Zealand Hirudinea: Pt. II, **Branchellion parkeri, *A New Ichthyobdellid Leech.*** Zoology Pub. No. 1. L. R. Richardson. Nov. 1949; ***Four New Species of Fresh-water Ciliates from New Zealand.*** Zoology Pub. No. 2. Brian M. Bary. Feb. 1950; ***New Zealand Coelenterates, Ctenophores from Cook Strait.*** Zoology Pub. No. 3. Patricia M. Ralph and C. Kaberry. March 1950; ***The Kirk Collection of Sponges in the Zoology Museum, Victoria University College.*** Zoology Pub. No. 4. H. Barraclough Fell. May 1950; ***Some Blood Parasites of New Zealand Birds.*** Zoology Pub. No. 5. Marshall Laird. May 1950; ***A New Genus and Two New Species of Peloridiidae (Homoptera) from New Zealand.*** Zoology Pub. No. 6. Carl J. Drake and J. T. Salmon. May 1950; ***A Study of the Marine Spiny Crayfish Jasus lalandii (Milne-Edwards).*** Zoology Pub. No. 7. C. A. Bradstock. Sept. 1950; ***Keys and Bibliography to the Collembola.*** Zoology Pub. No. 8. J. T. Salmon. Jan. 1951; ***Blood Parasites of Mammals in New Zealand*** and ***A Contribution to the Study of Fijian Haematozoa.*** Zoology Pubs. Nos. 9 and 10. Marshall Laird. Apr. 1951; ***Insects Collected from Aircraft Arriving in New Zealand from Abroad.*** Zoology Pub. No. 11. (Also *Royal New Zealand Air Force Entomol. Bull. No. 6.*) Marshall Laird. Wellington: Victoria Univ. College, Sept. 1951. (Distrib. on exchange basis from Dept. of Zoology.)

Important New Books



AN INTRODUCTION TO
ACAROLOGY

By Edward W. Baker and G. W. Wharton

Imbalances created by the use of new insecticides, new knowledge of tropical diseases, and new findings in other fields of agriculture and public health are revealing the importance of many heretofore unknown or little known mite and ticks. This book now provides the much-needed guide to all species identified up to the present. Keys to each of over 200 families and clear drawings of representatives of each make identification easy. Under each family are also lists of genera, the structural and biological features, economic or medical significance when known, and a bibliography. Any particular mite or tick may thus be quickly identified to determine whether it is pest, beneficial, or incidental. A complete, cross-referenced index further augments the usefulness of this most valuable book. $10.00

INSECT RESISTANCE IN CROP PLANTS

By Reginald H. Painter

Based on a thorough review of work done all over the world on plant-insect relationships and on the development of pest-resistant varieties of all kinds of crops, this book gives the scientific bases for and the accumulated data on plant resistance. It explains all factors of both plant and insect biology that enter into the development of resistance and its permanence. It analyzes the resistant varieties of wheat, corn, cotton, and other major crops, both from the entomological and from the plant breeding points of view; gives comparative figures on the effectiveness and cost of plant resistance and other control measures; suggests methods for further work on resistance; and gives extensive bibliographies on the various aspects of plant-insect relationships and on resistance in each of the specific grain, forage, fruit, vegetable, fiber, and other crops. $9.50

Order from your bookstore or from

THE MACMILLAN COMPANY
60 Fifth Avenue
New York 11, N.Y.

Meetings & Conferences

Apr. 3–8. The Physical Society (Annual). Exhibition of Scientific Instruments and Apparatus. Royal College of Science, London.

Apr. 4–5. History of Science Society. Brown University, Providence, R. I.

Apr. 4–5. National Aviation Education Council. Cooley Plaza Hotel, Boston.

Apr. 5. Association for Research in Ophthalmology, Midwestern Section (Annual). Indiana University Medical Center, Indianapolis.

Apr. 5–6. Eastern Sociological Society (Annual). Haverford College, Haverford, Pa.

Apr. 5–9. American Association of School Administrators (Regional). Boston.

Apr. 6–9. American College of Allergists (Annual). William Penn Hotel, Pittsburgh.

Apr. 6–9. National Agricultural Chemicals Association. Fairmont Hotel, San Francisco.

Apr. 7–8. Histochemical Society. Hotel New Yorker, New York.

Apr. 7–9. American Society of Lubrication Engineers (Annual). Hotel Statler, Cleveland.

Apr. 7–9. Seminar on International Wool Research Project. Lowell Textile Institute, Lowell, Mass.

Apr. 8–10. Faraday Society Discussion. Leeds, Yorkshire, Eng.

Apr. 9. International Association of Medical Museums. Hotel New Yorker, New York.

Apr. 10–12. American Association of Pathologists and Bacteriologists (Annual). Hotel New Yorker, New York.

Apr. 10–15. American Society of Ichthyologists and Herpetologists (Annual). University of Texas, Austin.

Apr. 11–12. Montana Academy of Sciences (Annual). Bozeman.

Apr. 14–18. American Physiological Society. New York.

Apr. 14–18. American Society of Biological Chemists (Annual). Hotel New Yorker, New York.

Apr. 14–18. American Society for Pharmacology and Experimental Therapeutics. Hotel Statler, New York.

Apr. 14–18. Federation of American Societies for Experimental Biology. Hotels Statler, New Yorker, McAlpin, and Governor Clinton, New York.

Apr. 14–18. Oil-Heat Institute of America (Annual). The Benjamin Franklin, Philadelphia.

Apr. 15. Massachusetts Society for Research in Psychiatry. Boston Psychopathic Hospital, Boston.

Apr. 15–17. Food and Container Institute, Research and Development Associates. Palmer House, Chicago.

Apr. 15–18. International Congress of Legal Medicine and of Social Medicine. Bern.

Apr. 16–18. National Petroleum Association (Semiannual). Hotel Cleveland, Cleveland.

Apr. 17–19. Ohio Academy of Science. Kent State University, Kent.

Apr. 17–20. American Heart Association. Hotel Statler, Cleveland.

Apr. 17–20. Institute for Education by Radio-Television (Annual). Deshler-Wallick Hotel, Columbus, Ohio.

Apr. 18–19. Association of Southeastern Biologists, Botanical Society of America (Southeastern Section), Southern Appalachian Botanical Club, Georgia Academy of Science (Biology Section). Agnes Scott College, Decatur, Ga.

PERSONNEL PLACEMENT

YOUR ad here reaches over 32,000 foremost scientists in the leading educational institutions, industrial laboratories, and research foundations in the U. S. and 76 foreign countries—at a very low cost

CLASSIFIED: 15¢ per word, minimum charge $3.00. Use of Box Number counts as 10 additional words.

DISPLAY: $17.50 per inch, no charge for Box Number.

Correct payment to SCIENCE must accompany all ads. Insertion usually made 2 or 3 weeks after receipt of ad.

SCIENCE • 1515 Mass. Ave., N.W., Wash. 5, D. C.

POSITIONS WANTED

Biochemist: Well-known, thirty years' research and teaching experience, medical institutions, many publications, seeks research professorship or equivalent. Box 138, SCIENCE. 4/4

Biochemist: Ph.D. Two years' medical school teaching experience. Desires new academic or industrial teaching position. Box 136, SCIENCE. 3/28

Botanist: Ph.D., Plant Physiology, Plant Pathology. Desires academic or industrial employment. Experience: Two years college teaching, two years research. Publications. Box 139, SCIENCE. 3/28

Plant Physiologist: Ph.D. Age 35. Three years' teaching experience in General Botany, Plant Physiology and agricultural applications of physiology. Experience in laboratory and field tests on herbicides. Available September. Box 140, SCIENCE. X

Positions Wanted:
(a) **Physician** seeks opportunity in medical research and teaching; Ph.D. degrees (Physiology, Pharmacology), several years' teaching experience; eight years, director, research foundation. (b) **Physicist**; Ph.D., particularly interested in academic appointment offering opportunity for research; (Well stocked physics library would help); for further information please write Science Division, Medical Bureau (Burneice Larson, Director), Palmolive Building, Chicago. X

Radiochemist-Biochemist Ph.D. 32; Eight years research and teaching experience in nucleic acid chemistry, organic bio-synthesis, proteins, enzymes, desires academic research with some teaching; East, publications. Box 127, SCIENCE. 3/21

Teaching—Biology, Zoology. M.S.; additional graduate work, teaching experience. Age 30. Box 141, SCIENCE X

Virologist: Experienced with famous workers, New York—New Jersey area. Box 137, SCIENCE. X

POSITIONS OPEN

Advanced theoretical and research scientists needed for fundamental and applied work on the University of Chicago campus. Complete facilities and excellent associations are available in this academic atmosphere. Various research projects deal with long-range problems of the Tactical Air Force. We offer salaries generally prevailing in industry as well as the security of a continuing position with this military laboratory. Applicants must be U. S. citizens. Write to Director of Scientific Personnel, Chicago Midway Laboratories, 6040 South Greenwood Avenue, Chicago 37, Illinois. X

Horticulturist: Instructorship; Teach horticulture, operate small experimental greenhouse and outdoor experimental area. Box 133, SCIENCE. X

Literature Scientist . . . for literature research in clinical and pre-clinical fields with well established Philadelphia pharmaceutical manufacturer. At least M.S. or equivalent experience, chemical-biological background, preferably pre-medical training, some experience in scientific literature searching. Liberal employee benefits, excellent working conditions and facilities. Salary open. Send complete details. Box 135, SCIENCE. X

LOOK AROUND... **notice the increasing number of satisfied advertisers using small-space ads regularly in practically every issue of SCIENCE—*proof that these small ads get results!* If you have a product or service of interest to scientists, why not take advantage of this low-cost means of increasing your profits!**

POSITIONS OPEN

Positions Open:
(a) **Pharmaceutical Chemist**; PhD. with knowledge of general pharmaceuticals and manufacturing techniques from laboratory stage to actual production; interesting opportunity; important company. (b) **Organic Chemist** and, also, Production Control Supervisor; East. (c) Young man with **Pharmacy** degree, advanced training in chemistry and minimum two years experience in pharmaceutical industry, preferably in product development; preferably Ph.D.; duties: application research; around $7200. (d) **Biochemist**; faculty appointment, university medical school; September. (e) **Chemist**; well qualified analytical, physical or inorganic chemistry; faculty appointment; opportunity directing department, general chemistry; Midwestern University. (f) **Physician** with flair for medical writing; key position; one of leading pharmaceutical companies. (g) **Physiologist**; research involving hypertension, adema and proteinuria in pregnant patients; department, obstetrics—gynecology, university medical school research appointment. S3-3 Science Division, Medical Bureau (Burneice Larson, Director) Palmolive Building, Chicago. X

SCIENTISTS—salaried positions, $3,600 to $25,000.
This confidential service for outstanding men who desire a change of connection, will develop and conduct preliminary negotiations without risk to present position. Send name and address for details.
TOMSETT ASSOCIATES • 335 Frick Bldg., Pittsburgh 19, Pa.

Young Teacher with degree in biology or related field. Prominent scientific instrument manufacturer needs additional personnel for sales trainees. Permanent position, with excellent opportunity. Send information on college major and subsequent experience. Box 132, SCIENCE. 3/21

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

YOUR ad here reaches over 32,000 foremost scientists in the leading educational institutions, industrial laboratories, and research foundations in the U. S. and 76 foreign countries—at a very low cost

CLASSIFIED: 20¢ per word, minimum charge $5.00. Use of Box Number counts as 10 additional words. Correct payment to SCIENCE must accompany ad.

DISPLAY: Rates listed below—no charge for Box Number. Monthly invoices will be sent on a charge account basis—providing satisfactory credit is established.

Single insertion	**$17.50 per inch**
7 times in 1 year	**16.00 per inch**
13 times in 1 year	**14.00 per inch**
26 times in 1 year	**12.50 per inch**
52 times in 1 year	**11.00 per inch**

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

AVOID DELAY . . . . ***Cash in Advance payment***
MUST be enclosed with ALL classified ads.
See "Charges and Requirements"

LANGUAGES

Listen and Learn a Language by LINGUAPHONE

At home learn to speak Spanish, French, German, Russian, Chinese—any of 29 languages available by quick, easy Linguaphone World's-Standard **Conversational** Method. Over a million Home-study students. Save time, work, money. *Send for* **Free** *book* **Today.**

LINGUAPHONE INSTITUTE • 8403 Radio City, New York 20

BOOKS

WANTED TO PURCHASE . . .
SCIENTIFIC PERIODICALS and BOOKS
Sets and runs, foreign and domestic. Entire libraries and smaller collections wanted.
WALTER J. JOHNSON • 125 East 23rd St., New York 10, N. Y.

The MARKET PLACE

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

BOOKS

Your sets and files of scientific journals are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, J. S. CANNER, INC. Boston 19, Massachusetts

SCIENTIFIC BOOKS and PERIODICALS WANTED
Complete libraries—Sets and runs—Single titles
Also, please send us your want lists.
STECHERT-HAFNER, INC.
31 East 10th St., New York 3

BACK NUMBER PERIODICALS — **Bought and Sold**
• Tell us what you want!—What have you to offer?
Abrahams Magazine Service Established 1889 ▶ DEPT. P, 56 E. 13th ST. NEW YORK 3, N. Y.

REPRINTS & SEPARATES our specialty!
But we also buy and sell books and periodicals on Conchology, Ornithology, Entomology, Ichthyology, Herpetology, Mammalogy, Biology, Botany, Geology. You are welcome to our mailing lists. Any book in print supplied Postpaid at current prices.
JOHN Q. BURCH, 1584-86 W. Vernon Ave., Los Angeles 62, Calif.

PROFESSIONAL SERVICES

A NATIONAL SERVICE

ALBERT TEACHERS AGENCY and COLLEGE BUREAU

RELIABLE and PERSONAL SERVICE
. . . to Colleges and Universities of the Nation and their Personnel. Originated and continued by three generations of the Albert family.
Member N.A.T.A.
25 E. Jackson Blvd. Chicago 4, Illinois

SINCE 1870
New Food Ingredients • New Drugs
ANIMAL TESTS
Analyses • Consultation • Research
LaWall & Harrisson
Bacteriologists
Chemists • Pharmacologists
Div. S, 1921 Walnut St., Philadelphia 3, Pa.

SUPPLIES AND EQUIPMENT

FOR MICROSCOPY—SHILLABER'S IMMERSION OIL
Numerous advantages over Cedar Oil.
Used in many leading laboratories.
Type A (low viscosity)—preferred by many.
Type B—regular viscosity
COMBINATION PACKET (1 oz of each type) $1
Stock bottles: 4 oz $1.50 1 lb. $4
Order from your dealer or write us for leaflet IMO—S
R. P. CARGILLE 118 Liberty St., New York 6, N. Y.

***automatic* Washers**
for Pipettes • Animal Cages • Laboratory Glassware
Please send for literature
HEINICKE Instrument Corp. • P.O. Box 2872 Hollywood, Florida

SUPPLIES AND EQUIPMENT

LABORATORY ANIMALS
• Clean healthy well-fed animals
Guaranteed suitable for your needs.
Reasonably priced—Dependable service

DOGS RATS RABBITS
CATS PIGEONS HAMSTERS
MICE POULTRY GUINEA PIGS

JOHN C. LANDIS • Hagerstown, Md.

For CONSISTENT Rats . . .
• *BUDD MT. RODENT FARM*
• *CHESTER, N. J.*
Breeders of a recognized strain of Wistar.

All AMINO ACIDS— natural, synthetic, unnatural, Rare Sugars, Biochemical Products, Reagents, New Pharmaceuticals in stock. Write or phone PLaza 7-8171 for complete price list.
BIOS LABORATORIES, INC. 17 West 60th Street, New York 23, N. Y.

GBI CATALOG No. 677
Lists more than 300 items for Research—Biological, Microbiological, Bacteriological, Biochemical, Nutritional. Write
***GENERAL* BIOCHEMICALS, INC.**
72 LABORATORY PARK • CHAGRIN FALLS, OHIO

APRIL 18.
SPRING BOOK ISSUE
Send your copy in, now!

CHEMICAL GLASS BEADS

Made of resistant Bohemian borosilicate glass, especially fire-hardened and alkali-free.

Non-corrosive—non-reactive—can be used in solution with safety and assurance.

Solid—Borosilicate Glass: 1/2, 1, 1 1/4, 2, 2 1/2, 3, 3 1/2, 4, 5 and 6 mm.

Perforated—Crystal Glass: 4, 5 and 6 mm.

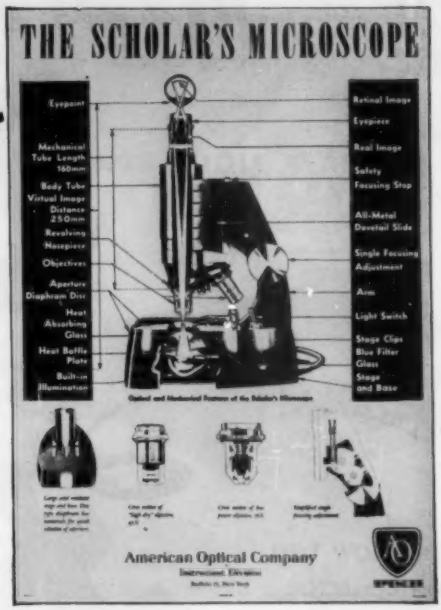
Made to ± 1/4 mm. tolerance.

Attractively priced: Send for prices, details and samples.

PROPPER MANUFACTURING CO., INC.
10-34 44th Drive, Long Island City 1, New York

Send for your AO Scholar's Microscope Wall Chart

(38" x 27")



NOW, instructors using the popular AO Spencer 78 and 79 Scholar's Microscopes can have a wall chart especially designed to help them teach the optical and mechanical principles—and proper use of these instruments.

Easy-to-follow light path is illustrated. Both optical and mechanical nomenclatures—valuable classroom aids—are listed.

FILL IN AND MAIL THIS COUPON TODAY

American Optical Company
Instrument Division
Buffalo 15, N. Y.

Date_____

GENTLEMEN: Yes, I would like a free Scholar's Microscope wall chart.

Please mail it to:_____
SCHOOL

_____
SCHOOL ADDRESS

_____
CITY, STATE

ATT. OF_____

SIGNED_____
TEACHER, PRINCIPAL, OR OTHER OFFICIAL

American Optical
COMPANY

INSTRUMENT DIVISION • BUFFALO 15, NEW YORK